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(54) Title: INHIBITORS OF FACTOR Xa

(57) Abstract: Novel compounds, their salts and compositions related thereto having activity against mammalian factor Xa are disclosed. The compounds are useful *in vitro* or *in vivo* for preventing or treating coagulation disorders.

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INHIBITORS OF FACTOR Xa

Related Applications

- This application claims benefit of priority under 35 USC § 119(e) to U.S.
- 5 Provisional Application No. 60/135,820 filed on May 24, 1999, which is herein incorporated in its entirety by reference.

Field of the Invention

- This invention relates to novel compounds which are potent and highly selective inhibitors of isolated factor Xa or when assembled in the prothrombinase
- 10 complex. These compounds show selectivity for factor Xa versus other proteases of the coagulation (e.g. thrombin, FVIIa, fIXa) or the fibrinolytic cascades (e.g. plasminogen activators, plasmin). In another aspect, the present invention relates to novel monoamidino-containing compounds, their pharmaceutically acceptable salts, and pharmaceutically acceptable compositions thereof which are useful as potent
- 15 and specific inhibitors of blood coagulation in mammals. In yet another aspect, the invention relates to methods for using these inhibitors as therapeutic agents for disease states in mammals characterized by coagulation disorders.

Background of the Invention

- Hemostasis, the control of bleeding, occurs by surgical means, or by the
- 20 physiological properties of vasoconstriction and coagulation. This invention is particularly concerned with blood coagulation and ways in which it assists in maintaining the integrity of mammalian circulation after injury, inflammation, disease, congenital defect, dysfunction or other disruption. Although platelets and blood coagulation are both involved in thrombus formation, certain components of
- 25 the coagulation cascade are primarily responsible for the amplification or acceleration of the processes involved in platelet aggregation and fibrin deposition.

- Thrombin is a key enzyme in the coagulation cascade as well as in hemostasis. Thrombin plays a central role in thrombosis through its ability to catalyze the conversion of fibrinogen into fibrin and through its potent platelet activation activity. Direct or indirect inhibition of thrombin activity has been the
- 30 focus of a variety of recent anticoagulant strategies as reviewed by Claeson, G., "Synthetic Peptides and Peptidomimetics as Substrates and Inhibitors of Thrombin

and Other Proteases in the Blood Coagulation System", Blood Coag. Fibrinol. 5, 411-436 (1994). Several classes of anticoagulants currently used in the clinic directly or indirectly affect thrombin (i.e. heparins, low-molecular weight heparins, heparin-like compounds and coumarins).

- 5 A prothrombinase complex, including Factor Xa (a serine protease, the activated form of its Factor X precursor and a member of the calcium ion binding, gamma carboxyglutamyl (Gla)-containing, vitamin K dependent, blood coagulation glycoprotein family), converts the zymogen prothrombin into the active procoagulant thrombin. Unlike thrombin, which acts on a variety of protein
- 10 substrates as well as at a specific receptor, factor Xa appears to have a single physiologic substrate, namely prothrombin. Since one molecule of factor Xa may be able to generate up to 138 molecules of thrombin (Elodi et al., *Thromb. Res.* 15, 617-619 (1979)), direct inhibition of factor Xa as a way of indirectly inhibiting the formation of thrombin may be an efficient anticoagulant strategy. Therefore, it has
- 15 been suggested that compounds which selectively inhibit factor Xa may be useful as *in vitro* diagnostic agents, or for therapeutic administration in certain thrombotic disorders, see *e.g.*, WO 94/13693.

- Polypeptides derived from hematophagous organisms have been reported which are highly potent and specific inhibitors of factor Xa. United States Patent
- 20 4,588,587 describes anticoagulant activity in the saliva of the Mexican leech, *Haementeria officinalis*. A principal component of this saliva was shown to be the polypeptide factor Xa inhibitor, antistasin (ATS), by Nutt, E. *et al.*, "The Amino Acid Sequence of Antistasin, a Potent Inhibitor of Factor Xa Reveals a Repeated Internal Structure", *J. Biol. Chem.*, 263, 10162-10167 (1988). Another potent and
- 25 highly specific inhibitor of Factor Xa, called tick anticoagulant peptide (TAP), has been isolated from the whole body extract of the soft tick *Ornithodoros moubata*, as reported by Waxman, L., *et al.*, "Tick Anticoagulant Peptide (TAP) is a Novel Inhibitor of Blood Coagulation Factor Xa" *Science*, 248, 593-596 (1990).

- Factor Xa inhibitory compounds which are not large polypeptide-type
- 30 inhibitors have also been reported including: Tidwell, R.R. *et al.*, "Strategies for Anticoagulation With Synthetic Protease Inhibitors. Xa Inhibitors Versus Thrombin Inhibitors", *Thromb. Res.*, 19, 339-349 (1980); Turner, A.D. *et al.*, "p-Amidino Esters as Irreversible Inhibitors of Factor IXa and Xa and Thrombin", *Biochemistry*, 25, 4929-4935 (1986); Hitomi, Y. *et al.*, "Inhibitory Effect of New Synthetic

- Protease Inhibitor (FUT-175) on the Coagulation System", *Haemostasis*, 15, 164-168 (1985); Sturzebecher, J. *et al.*, "Synthetic Inhibitors of Bovine Factor Xa and Thrombin. Comparison of Their Anticoagulant Efficiency", *Thromb. Res.*, 54, 245-252 (1989); Kam, C.M. *et al.*, "Mechanism Based Isocoumarin Inhibitors for
- 5 Trypsin and Blood Coagulation Serine Proteases: New Anticoagulants", *Biochemistry*, 27, 2547-2557 (1988); Hauptmann, J. *et al.*, "Comparison of the Anticoagulant and Antithrombotic Effects of Synthetic Thrombin and Factor Xa Inhibitors", *Thromb. Haemost.*, 63, 220-223 (1990); and the like.

- Others have reported Factor Xa inhibitors which are small molecule organic
- 10 compounds, such as nitrogen containing heterocyclic compounds which have amidino substituent groups, wherein two functional groups of the compounds can bind to Factor Xa at two of its active sites. For example, WO 98/28269 describes pyrazole compounds having a terminal C(=NH)-NH₂ group; WO 97/21437 describes benzimidazole compounds substituted by a basic radical which are connected to a
- 15 naphthyl group via a straight or branched chain alkylene, -C(=O) or -S(=O)₂ bridging group; WO 99/10316 describes compounds having a 4-phenyl-N-alkylamidino-piperidine and 4-phenoxy-N-alkylamidino-piperidine group connected to a 3-amidinophenyl group via a carboxamidealkyleneamino bridge; and EP 798295 describes compounds having a 4-phenoxy-N-alkylamidino-piperidine group
- 20 connected to an amidinonaphthyl group via a substituted or unsubstituted sulfonamide or carboxamide bridging group.

- There exists a need for effective therapeutic agents for the regulation of hemostasis, and for the prevention and treatment of thrombus formation and other
- 25 pathological processes in the vasculature induced by thrombin such as restenosis and inflammation. In particular, there continues to be a need for compounds which selectively inhibit factor Xa or its precursors. Compounds that have different combinations of bridging groups and functional groups than compounds previously discovered are needed, particularly compounds which selectively or preferentially bind to Factor Xa. Compounds with a higher degree of binding to Factor Xa than to
- 30 thrombin are desired, especially those compounds having good bioavailability and/or solubility.

Summary of the Invention

The present invention relates to novel compounds which inhibit factor Xa, their pharmaceutically acceptable isomers, salts, hydrates, solvates and prodrug derivatives, and pharmaceutically acceptable compositions thereof which have particular biological properties and are useful as potent and specific inhibitors of blood coagulation in mammals. In another aspect, the invention relates to methods of using these inhibitors as diagnostic reagents or as therapeutic agents for disease states in mammals which have coagulation disorders, such as in the treatment or prevention of any thrombotically mediated acute coronary or cerebrovascular syndrome, any thrombotic syndrome occurring in the venous system, any coagulopathy, and any thrombotic complications associated with extracorporeal circulation or instrumentation, and for the inhibition of coagulation in biological samples.

In certain embodiments, this invention relates to novel compounds which are potent and highly selective inhibitors of isolated factor Xa when assembled in the prothrombinase complex. These compounds show selectivity for factor Xa versus other proteases of the coagulation cascade (e.g. thrombin, etc.) or the fibrinolytic cascade, and are useful as diagnostic reagents as well as antithrombotic agents.

In a preferred embodiment, the present invention provides a compound of the formula I:



wherein:

A is selected from:

- (a) C_1-C_6 -alkyl;
- (b) C_3-C_8 -cycloalkyl;
- (c) phenyl, which is independently substituted with 0-2 R^1 substituents;
- (d) naphthyl, which is independently substituted with 0-2 R^1 substituents; and
- (e) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are

selected from N, O and S, and wherein the ring system may be substituted from 0-2 R¹ substituents;

R¹ is selected from:

- 5 Halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₆₋₄alkylC₃₋₈-cycloalkyl, -CN, -NO₂, (CH₂)_mNR²R³, SO₂NR²R³, SO₂R², CF₃, OR², and a 5-6 membered aromatic heterocyclic system containing from 1-4 heteroatoms selected from N, O and S, wherein from 1-4 hydrogen atoms on the aromatic heterocyclic system may be independently replaced with a member selected from the group consisting of halo, C₁-C₄-alkyl, -CN C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋
- 10 ₆alkynyl, C₃₋₈cycloalkyl, C₆₋₄alkylC₃₋₈cycloalkyl and -NO₂;

R² and R³ are independently selected from the group consisting of:

- H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₆₋₄alkylC₃₋₈cycloalkyl, C₆₋₄alkylphenyl and C₆₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently
- 15 replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₆₋₄alkylC₃₋₈cycloalkyl, -CN, and -NO₂;

m is an integer of 0-2;

Y is a member selected from the group consisting of:

- 20 a direct link, -C(=O)-, -N(R⁴)-, -C(=O)-N(R⁴)-, -N(R⁴)-C(=O)-, -SO₂-, -O-, -SO₂-N(R⁴)- and -N(R⁴)-SO₂-;

R⁴ is selected from:

- H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₆₋₄alkylC₃₋₈cycloalkyl, C₆₋₄alkylphenyl and C₆₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently
- 25 replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₆₋₄alkylC₃₋₈cycloalkyl, -CN, and -NO₂;

D is a direct link or is a member selected from the group consisting of:

- 30 (a) phenyl, which is independently substituted with 0-2 R^{1a} substituents;

- 6 -

- (b) naphthyl, which is independently substituted with 0-2 R^{1a} substituents; and
- (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

R^{1a} is selected from:

Halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN, -NO₂, (CH₂)_mNR^{2a}R^{3a}, SO₂NR^{2a}R^{3a}, SO₂R^{2a}, CF₃, OR^{2a}, and a 5-6 membered aromatic heterocyclic system containing from 1-4 heteroatoms selected from N, O and S, wherein from 1-4 hydrogen atoms on the aromatic heterocyclic system may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂;

- 15 R^{2a} and R^{3a} are independently selected from the group consisting of:

H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂;

E is a member selected from the group consisting of:

-N(R⁵)-C(=O)-, -C(=O)-N(R⁵)-, -N(R⁵)-C(=O)-N(R⁶)-, -SO₂-N(R⁵)-, -N(R⁵)-SO₂-N(R⁶)- and -N(R⁵)-SO₂-N(R⁶)-C(=O)-;

- 25 R⁵ and R⁶ are independently selected from:

H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, C₀₋₄alkylheteroaryl, C₁₋₄alkylCOOH and C₁₋₄alkylCOOC₁₋₄alkyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl, naphthyl and heteroaryl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl,

C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂;

G is selected from:

-CR⁷R⁸- and -CR^{7a}R^{8a}-CR^{7b}R^{8b}-

- 5 wherein R⁷, R⁸, R^{7a}, R^{8a}, R^{7b} and R^{8b} are independently a member selected from from the group consisting of:

- hydrogen, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, C₀₋₄alkylCOOR⁹,
 -C₀₋₄alkylC(=O)NR⁹R¹⁰, -C₀₋₄alkylC(=O)NR⁹-CH₂-CH₂-O-R¹⁰,
 10 -C₀₋₄alkylC(=O)NR⁹-(CH₂-CH₂-O-R¹⁰)₂, -N(R⁹)COR¹⁰, -N(R⁹)C(=O)R¹⁰,
 -N(R⁹)SO₂R¹⁰, and a naturally occurring or synthetic amino acid side chain,
 wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and
 naphthyl moieties may be independently replaced with a member selected
 from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, -CN and -NO₂;

- 15

R⁹ and R¹⁰ are independently selected from:

- H, C₁₋₄alkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4
 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may
 be independently replaced with a member selected from the group consisting
 20 of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, -CN and -NO₂, and wherein R⁹ and R¹⁰ taken together can form a
 5-8 membered heterocyclic ring;

J is a member selected from the group consisting of:

- 25 a direct link, -C(=O)-N(R¹¹)-(CH₂)₀₋₂, -N(R¹¹)-(CH₂)₀₋₂-C(=O)-, and -N(R¹¹)-(CH₂)₀₋₂;

R¹¹ is a member selected from the group consisting of:

- hydrogen, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, C₀₋₄alkylheterocyclic ring
 having from 1 to 4 hetero ring atoms selected from the group consisting of N,
 30 O and S, CH₂COOC₁₋₄alkyl, CH₂COOC₁₋₄alkylphenyl and
 CH₂COOC₁₋₄alkylnaphthyl;

Z is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1b} substituents;
- (b) naphthyl, which is independently substituted with 0-2 R^{1b} substituents; and
- 5 (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1b} substituents;

R^{1b} is selected from:

- 10 Halo, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, -CN, -NO₂, $NR^{2b}R^{3b}$, $SO_2NR^{2b}R^{3b}$, SO_2R^{2b} , CF₃, OR^{2b}, O-CH₂-Ph, O-CH₂-OPh, O-CH₂-CH₂-OR^{2b}, O-CH₂-COOR^{2b}, N(R^{2b})-CH₂-CH₂-OR^{2b}, N(-CH₂-CH₂-OR^{2b}), N(R^{2b})-C(=O)R^{3b}, N(R^{2b})-SO₂-R^{3b}, and a 5-6 membered aromatic heterocyclic system containing from 1-4 heteroatoms selected from N, O and S, wherein from 1-4 hydrogen atoms on the aromatic heterocyclic system may be independently replaced with a member selected from the group consisting of halo, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, -CN and -NO₂;
- 15

R^{2b} and R^{3b} are independently selected from the group consisting of:

- 20 H, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, C_{6-4} alkylphenyl and C_{6-4} alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, -CN and -NO₂;
- 25

L is selected from:

H, -CN, C(=O)NR¹²R¹³, (CH₂)_nNR¹²R¹³, C(=NR¹²)NR¹²R¹³, OR¹², NR¹²R¹³, -NR¹²C(=NR¹³)NR¹²R¹³, and NR¹²C(=NR¹³)-R¹³;

R¹² and R¹³ are independently selected from:

hydrogen, -OR¹⁴, -NR¹⁴R¹⁵, C₁₋₄alkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, COOC₁₋₄alkyl, COO-C₀₋₄alkylphenyl and COO-C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN, and -NO₂;

R¹⁴ and R¹⁵ are independently selected from:

H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN, and -NO₂;

and all pharmaceutically acceptable isomers, salts, hydrates, solvates and prodrug derivatives thereof.

In certain aspects of this invention, compounds are provided which are useful as diagnostic reagents. In another aspect, the present invention includes pharmaceutical compositions comprising a pharmaceutically effective amount of the compounds of this invention and a pharmaceutically acceptable carrier. In yet another aspect, the present invention includes methods comprising using the above compounds and pharmaceutical compositions for preventing or treating disease states characterized by undesired thrombosis or disorders of the blood coagulation process in mammals, or for preventing coagulation in biological samples such as, for example, stored blood products and samples. Optionally, the methods of this invention comprise administering the pharmaceutical composition in combination with an additional therapeutic agent such as an antithrombotic and/or a thrombolytic agent and/or an anticoagulant.

The preferred compounds also include their pharmaceutically acceptable isomers, hydrates, solvates, salts and prodrug derivatives.

Detailed Description of the Invention

Definitions

In accordance with the present invention and as used herein, the following terms are defined with the following meanings, unless explicitly stated otherwise.

The term "alkenyl" refers to a trivalent straight chain or branched chain unsaturated aliphatic radical. The term "alkinyl" (or "alkynyl") refers to a straight or
5 branched chain aliphatic radical that includes at least two carbons joined by a triple bond. If no number of carbons is specified alkenyl and alkynyl each refer to radicals having from 2-12 carbon atoms.

The term "alkyl" refers to saturated aliphatic groups including straight-chain, branched-chain and cyclic groups having the number of carbon atoms specified, or if
10 no number is specified, having up to 12 carbon atoms. The term "cycloalkyl" as used herein refers to a mono-, bi-, or tricyclic aliphatic ring having 3 to 14 carbon atoms and preferably 3 to 7 carbon atoms.

As used herein, the terms "carbocyclic ring structure" and "C₃₋₁₆ carbocyclic
mono, bicyclic or tricyclic ring structure" or the like are each intended to mean
15 stable ring structures having only carbon atoms as ring atoms wherein the ring structure is a substituted or unsubstituted member selected from the group consisting of: a stable monocyclic ring which is aromatic ring ("aryl") having six ring atoms; a stable monocyclic non-aromatic ring having from 3 to 7 ring atoms in the ring; a stable bicyclic ring structure having a total of from 7 to 12 ring atoms in the two
20 rings wherein the bicyclic ring structure is selected from the group consisting of ring structures in which both of the rings are aromatic, ring structures in which one of the rings is aromatic and ring structures in which both of the rings are non-aromatic; and a stable tricyclic ring structure having a total of from 10 to 16 atoms in the three rings wherein the tricyclic ring structure is selected from the group consisting of:
25 ring structures in which three of the rings are aromatic, ring structures in which two of the rings are aromatic and ring structures in which three of the rings are non-aromatic. In each case, the non-aromatic rings when present in the monocyclic, bicyclic or tricyclic ring structure may independently be saturated, partially saturated or fully saturated. Examples of such carbocyclic ring structures include, but are not
30 limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, adamantyl, cyclooctyl, [3.3.0]bicyclooctane, [4.3.0]bicyclononane, [4.4.0]bicyclodecane (decalin), 2.2.2]bicyclooctane, fluorenyl, phenyl, naphthyl, indanyl, adamantyl, or tetrahydronaphthyl (tetralin). Moreover, the ring structures described herein may be attached to one or more indicated pendant groups via any carbon atom which results

in a stable structure. The term "substituted" as used in conjunction with carbocyclic ring structures means that hydrogen atoms attached to the ring carbon atoms of ring structures described herein may be substituted by one or more of the substituents indicated for that structure if such substitution(s) would result in a stable compound.

- 5 The term "aryl" which is included with the term "carbocyclic ring structure" refers to an unsubstituted or substituted aromatic ring, substituted with one, two or three substituents selected from loweralkoxy, loweralkyl, loweralkylamino, hydroxy, halogen, cyano, hydroxyl, mercapto, nitro, thioalkoxy, carboxaldehyde, carboxyl, carboalkoxy and carboxamide, including but not limited to carbocyclic aryl,
10 heterocyclic aryl, and biaryl groups and the like, all of which may be optionally substituted. Preferred aryl groups include phenyl, halophenyl, loweralkylphenyl, naphthyl, biphenyl, phenanthrenyl and naphthacenyl.

- The term "aryalkyl" which is included with the term "carbocyclic aryl" refers to one, two, or three aryl groups having the number of carbon atoms
15 designated, appended to an alkyl group having the number of carbon atoms designated. Suitable aryalkyl groups include, but are not limited to, benzyl, picolyl, naphthylmethyl, phenethyl, benzyhydrl, trityl, and the like, all of which may be optionally substituted.

- As used herein, the term "heterocyclic ring" or "heterocyclic ring system" is
20 intended to mean a substituted or unsubstituted member selected from the group consisting of stable monocyclic ring having from 5-7 members in the ring itself and having from 1 to 4 hetero ring atoms selected from the group consisting of N, O and S; a stable bicyclic ring structure having a total of from 7 to 12 atoms in the two rings wherein at least one of the two rings has from 1 to 4 hetero atoms selected
25 from N, O and S, including bicyclic ring structures wherein any of the described stable monocyclic heterocyclic rings is fused to a hexane or benzene ring; and a stable tricyclic heterocyclic ring structure having a total of from 10 to 16 atoms in the three rings wherein at least one of the three rings has from 1 to 4 hetero atoms selected from the group consisting of N, O and S. Any nitrogen and sulfur atoms
30 present in a heterocyclic ring of such a heterocyclic ring structure may be oxidized. Unless indicated otherwise the terms "heterocyclic ring" or "heterocyclic ring system" include aromatic rings, as well as non-aromatic rings which can be saturated, partially saturated or fully saturated non-aromatic rings. Also, unless indicated otherwise the term "heterocyclic ring system" includes ring structures

wherein all of the rings contain at least one hetero atom as well as structures having less than all of the rings in the ring structure containing at least one hetero atom, for example bicyclic ring structures wherein one ring is a benzene ring and one of the rings has one or more hetero atoms are included within the term "heterocyclic ring systems" as well as bicyclic ring structures wherein each of the two rings has at least one hetero atom. Moreover, the ring structures described herein may be attached to one or more indicated pendant groups via any hetero atom or carbon atom which results in a stable structure. Further, the term "substituted" means that one or more of the hydrogen atoms on the ring carbon atom(s) or nitrogen atom(s) of the each of the rings in the ring structures described herein may be replaced by one or more of the indicated substituents if such replacement(s) would result in a stable compound. Nitrogen atoms in a ring structure may be quaternized, but such compounds are specifically indicated or are included within the term "a pharmaceutically acceptable salt" for a particular compound. When the total number of O and S atoms in a single heterocyclic ring is greater than 1, it is preferred that such atoms not be adjacent to one another. Preferably, there are no more than 1 O or S ring atoms in the same ring of a given heterocyclic ring structure.

Examples of monocyclic and bicyclic heterocyclic ring systems, in alphabetical order, are acridinyl, azocinyl, benzimidazolyl, benzofuranyl, benzothiofuranyl, benzothiophenyl, benzoxazolyl, benzthiazolyl, benztriazolyl, benztetrazolyl, benzisoxazolyl, benziisothiazolyl, benzimidazalinyl, carbazolyl, 4aH-carbazolyl, carbolinyl, chromanyl, chromenyl, cinnolinyl, decahydroquinolinyl, 2H,6H-1,5,2-dithiazinyl, dihydrofuro[2,3-b]tetrahydrofuran, furanyl, furazanyl, imidazolidinyl, imidazolinyl, imidazolyl, 1H-indazolyl, indolinyl, indoliziny, indolyl, 3H-indolyl, isobenzofuranyl, isochromanyl, isoindazolyl, isoindolinyl, isoindolyl, isoquinolinyl (benzimidazolyl), isothiazolyl, isoxazolyl, morpholinyl, naphthyridinyl, octahydroisoquinolinyl, oxadiazolyl, 1,2,3-oxadiazolyl, 1,2,4-oxadiazolyl, 1,2,5-oxadiazolyl, 1,3,4-oxadiazolyl, oxazolidinyl, oxazolyl, oxazolidinyl, pyrimidinyl, phenanthridinyl, phenanthrolinyl, phenazinyl, phenothiazinyl, phenoxathiinyl, phenoxazinyl, phthalazinyl, piperazinyl, piperidinyl, pteridinyl, purinyl, pyranyl, pyrazinyl, pyrazolidinyl, pyrazolinyl, pyrazolyl, pyridazinyl, pyridoazole, pyridoimidazole, pyridothiazole, pyridinyl, pyridyl, pyrimidinyl, pyrrolidinyl, pyrrolinyl, 2H-pyrrolyl, pyrrolyl, quinazolinyl, quinolinyl, 4H-quinoliziny, quinoxalinyl, quinuclidinyl, tetrahydrofuranyl, tetrahydroisoquinolinyl, tetrahydroquinolinyl, 6H-1,2,5-thiadiazinyl,

1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,2,5-thiadiazolyl, 1,3,4-thiadiazolyl, thianthrenyl, thiazolyl, thienyl, thienothiazolyl, thienooxazolyl, thienoimidazolyl, thiophenyl, triazinyl, 1,2,3-triazolyl, 1,2,4-triazolyl, 1,2,5-triazolyl, 1,3,4-triazolyl and xanthenyl. Preferred heterocyclic ring structures include, but are not limited to, pyridinyl, furanyl, thienyl, pyrrolyl, pyrazolyl, pyrrolidinyl, imidazolyl, indolyl, benzimidazolyl, 1H-indazolyl, oxazoliny, or isatinoyl. Also included are fused ring and spiro compounds containing, for example, the above heterocyclic ring structures.

As used herein the term "aromatic heterocyclic ring system" has essentially the same definition as for the monocyclic and bicyclic ring systems except that at least one ring of the ring system is an aromatic heterocyclic ring or the bicyclic ring has an aromatic or non-aromatic heterocyclic ring fused to an aromatic carbocyclic ring structure.

The terms "halo" or "halogen" as used herein refer to Cl, Br, F or I substituents. The term "haloalkyl", and the like, refer to an aliphatic carbon radicals having at least one hydrogen atom replaced by a Cl, Br, F or I atom, including mixtures of different halo atoms. Trihaloalkyl includes trifluoromethyl and the like as preferred radicals, for example.

The term "methylene" refers to $-CH_2-$.

The term "pharmaceutically acceptable salts" includes salts of compounds derived from the combination of a compound and an organic or inorganic acid. These compounds are useful in both free base and salt form. In practice, the use of the salt form amounts to use of the base form; both acid and base addition salts are within the scope of the present invention.

"Pharmaceutically acceptable acid addition salt" refers to salts retaining the biological effectiveness and properties of the free bases and which are not biologically or otherwise undesirable, formed with inorganic acids such as hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid and the like, and organic acids such as acetic acid, propionic acid, glycolic acid, pyruvic acid, oxalic acid, maleic acid, malonic acid, succinic acid, fumaric acid, tartaric acid, citric acid, benzoic acid, cinnamic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, p-toluenesulfonic acid, salicylic acid and the like.

"Pharmaceutically acceptable base addition salts" include those derived from

inorganic bases such as sodium, potassium, lithium, ammonium, calcium, magnesium, iron, zinc, copper, manganese, aluminum salts and the like. Particularly preferred are the ammonium, potassium, sodium, calcium and magnesium salts.

Salts derived from pharmaceutically acceptable organic nontoxic bases include salts

- 5 of primary, secondary, and tertiary amines, substituted amines including naturally occurring substituted amines, cyclic amines and basic ion exchange resins, such as isopropylamine, trimethylamine, diethylamine, triethylamine, tripropylamine, ethanolamine, 2-diethylaminoethanol, trimethamine, dicyclohexylamine, lysine, arginine, histidine, caffeine, procaine, hydrabamine, choline, betaine,
- 10 ethylenediamine, glucosamine, methylglucamine, theobromine, purines, piperazine, piperidine, N-ethylpiperidine, polyamine resins and the like. Particularly preferred organic nontoxic bases are isopropylamine, diethylamine, ethanolamine, trimethamine, dicyclohexylamine, choline, and caffeine.

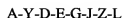
- "Biological property" for the purposes herein means an *in vivo* effector or
- 15 antigenic function or activity that is directly or indirectly performed by a compound of this invention that are often shown by *in vitro* assays. Effector functions include receptor or ligand binding, any enzyme activity or enzyme modulatory activity, any carrier binding activity, any hormonal activity, any activity in promoting or inhibiting adhesion of cells to an extracellular matrix or cell surface molecules, or
- 20 any structural role. Antigenic functions include possession of an epitope or antigenic site that is capable of reacting with antibodies raised against it.

- In the compounds of this invention, carbon atoms bonded to four non-identical substituents are asymmetric. Accordingly, the compounds may exist as diastereoisomers, enantiomers or mixtures thereof. The syntheses described herein
- 25 may employ racemates, enantiomers or diastereomers as starting materials or intermediates. Diastereomeric products resulting from such syntheses may be separated by chromatographic or crystallization methods, or by other methods known in the art. Likewise, enantiomeric product mixtures may be separated using the same techniques or by other methods known in the art. Each of the asymmetric
- 30 carbon atoms, when present in the compounds of this invention, may be in one of two configurations (R or S) and both are within the scope of the present invention.

Preferred Embodiments

In a preferred embodiment, the present invention provides a compound

according to the formula I:



wherein:

A is selected from:

- 5 (a) $\text{C}_1\text{-C}_6\text{-alkyl}$;
- (b) $\text{C}_3\text{-C}_8\text{-cycloalkyl}$;
- (c) phenyl, which is independently substituted with 0-2 R^1 substituents;
- (d) naphthyl, which is independently substituted with 0-2 R^1 substituents;
 and
- 10 (e) a monocyclic or fused bicyclic heterocyclic ring system having from
 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are
 selected from N, O and S, and wherein the ring system may be
 substituted from 0-2 R^1 substituents;

R^1 is selected from:

- 15 halo, $\text{C}_{1-4}\text{alkyl}$, $-\text{CN}$, $(\text{CH}_2)_m\text{NR}^2\text{R}^3$, $\text{SO}_2\text{NR}^2\text{R}^3$, SO_2R^2 , CF_3 , OR^2 , and a 5-6
 membered aromatic heterocyclic system containing from 1-4 heteroatoms
 selected from N, O and S;

R^2 and R^3 are independently selected from the group consisting of:

H, $\text{C}_{1-4}\text{alkyl}$ and $\text{C}_{0-4}\text{alkylaryl}$,

- 20 m is an integer of 0-2;

Y is a member selected from the group consisting of:

a direct link, $-\text{C}(=\text{O})-$, $-\text{N}(\text{R}^4)-$, $-\text{C}(=\text{O})-\text{N}(\text{R}^4)-$, $-\text{N}(\text{R}^4)-\text{C}(=\text{O})-$, $-\text{SO}_2-$, $-\text{O}-$,
 $-\text{SO}_2-\text{N}(\text{R}^4)-$ and $-\text{N}(\text{R}^4)-\text{SO}_2-$;

R^4 is selected from:

- 25 H, $\text{C}_{1-4}\text{alkyl}$ and $\text{C}_{0-4}\text{alkylaryl}$;

D is absent or is a member selected from the group consisting of:

- (a) aryl, which is independently substituted with 0-2 R^{1a} substituents; and

- (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

5 R^{1a} is selected from:

Halo, C₁₋₄alkyl, -CN, -NO₂, (CH₂)_mNR^{2a}R^{3a}, SO₂NR^{2a}R^{3a}, SO₂R^{2a}, CF₃, OR^{2a}, and a 5-6 membered aromatic heterocyclic ring containing from 1-4 heteroatoms selected from N, O and S;

R^{2a} and R^{3a} are independently selected from the group consisting of:

10 H, C₁₋₄alkyl and C₀₋₄alkylaryl;

E is a member selected from the group consisting of:

-N(R⁵)-C(=O)-, -C(=O)-N(R⁵)-, -N(R⁵)-C(=O)-N(R⁶)-, -SO₂-N(R⁵)-, -N(R⁵)-SO₂-N(R⁶)- and -N(R⁵)-SO₂-N(R⁶)-C(=O)-;

R⁵ and R⁶ are independently selected from:

15 H, C₁₋₄alkyl, C₀₋₄alkylaryl, C₀₋₄alkylheteroaryl, C₁₋₄alkylCOOH and C₁₋₄alkylCOOC₁₋₄alkyl;

G is selected from:

-CR⁷R⁸- and -CR^{7a}R^{8a}-CR^{7b}R^{8b}-

wherein R⁷, R⁸, R^{7a}, R^{8a}, R^{7b} and R^{8b} are independently a member selected from from

20 the group consisting of:

hydrogen, C₁₋₄alkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, C₀₋₄alkylaryl, -C₀₋₄alkylCOOR⁹, -C₀₋₄alkylC(=O)NR⁹R¹⁰, -N(R⁹)COR¹⁰, -N(R⁹)C(=O)R¹⁰, -N(R⁹)SO₂R¹⁰, and common amino acid side chains;

R⁹ and R¹⁰ are independently selected from:

25 H, C₁₋₄alkyl and C₀₋₄alkylaryl;

J is a member selected from the group consisting of:

a direct link, -C(=O)-N(R¹¹)-(CH₂)₀₋₂-, -N(R¹¹)-(CH₂)₀₋₂-C(=O)-, and -N(R¹¹)-(CH₂)₀₋₂;

R¹¹ is a member selected from the group consisting of:

hydrogen, C₁₋₄alkyl, C₂₋₆alkenyl, C₃₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylaryl, C₀₋₄alkylheterocyclics, CH₂COOC₁₋₄alkyl, CH₂COOC₁₋₄alkylaryl;

Z is a member selected from the group consisting of:

- 5 (a) aryl, which is independently substituted with 0-2 R^{1b} substituents; and
- (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1b} substituents;

10 R^{1b} is selected from:

halo, C₁₋₄alkyl, -CN, -NO₂, NR^{2b}R^{3b}, SO₂NR^{2b}R^{3b}, SO₂R^{2b}, CF₃, OR^{2b}, O-CH₂-CH₂-OR^{2b}, O-CH₂-COOR^{2b}, N(R^{2b})-CH₂-CH₂-OR^{2b}, N(-CH₂-CH₂-OR^{2b})₂, N(R^{2b})-C(=O)R^{3b}, N(R^{2b})-SO₂-R^{3b}, and a 5-6 membered aromatic heterocyclic ring containing from 1-4 heteroatoms selected from N, O and S;

15 R^{2b} and R^{3b} are independently selected from the group consisting of:

H, C₁₋₄alkyl and C₀₋₄alkylaryl;

L is selected from:

H, -CN, C(=O)NR¹²R¹³, (CH₂)_nNR¹²R¹³, C(=NR¹²)NR¹²R¹³, OR¹², -NR¹²C(=NR¹²)NR¹²R¹³ and NR¹²C(=NR¹²)-R¹³;

20 R¹² and R¹³ are independently selected from:

hydrogen, -OR¹⁴, -NR¹⁴R¹⁵, C₁₋₄alkyl, C₀₋₄alkylaryl, COOC₁₋₄alkyl, and COO-C₀₋₄alkylaryl;

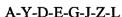
R¹⁴ and R¹⁵ are independently selected from:

H and C₁₋₄alkyl; and

25 all pharmaceutically acceptable isomers, salts, hydrates, solvates and prodrug derivatives thereof.

In a further preferred embodiment, the present invention provides a

compound according to the formula I:



wherein:

A is selected from:

- 5 (a) phenyl, which is independently substituted with 0-2 R^1 substituents; and
- (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be
- 10 substituted from 0-2 R^1 substituents;

R^1 is selected from:

halo, $(CH_2)_mNR^2R^3$, $SO_2NR^2R^3$ and SO_2R^2 ;

R^2 and R^3 are independently selected from the group consisting of:

H and C_{1-4} alkyl;

- 15 Y is a member selected from the group consisting of:

a direct link, $-C(=O)-$, $-SO_2-$ and $-O-$;

D is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1a} substituents; and
- 20 (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

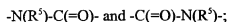
R^{1a} is selected from:

- 25 Halo and C_{1-4} alkyl;

R^{2a} and R^{3a} are independently selected from the group consisting of:

H, C_{1-4} alkyl, C_{0-4} alkylaryl;

E is a member selected from the group consisting of:



R^5 and R^6 are independently selected from:

H, C_{1-4} alkyl, C_{0-4} alkylaryl and C_{0-4} alkylheteroaryl;

5 G is selected from:



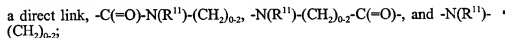
wherein R^7 , R^8 , R^{7a} , R^{8a} , R^{7b} and R^{8b} are independently a member selected from from the group consisting of:

10 hydrogen, C_{1-4} alkyl, C_{0-4} alkyl- C_{3-6} cycloalkyl, C_{0-4} alkylaryl, $-C_{0-4}$ alkylCOOR⁹,
 $-C_{0-4}$ alkylC(=O)NR⁹R¹⁰, $-C_{0-4}$ alkylC(=O)NR⁹-CH₂-CH₂-O-R¹⁰,
 $-C_{0-4}$ alkylC(=O)NR⁹(-CH₂-CH₂-O-R¹⁰)₂, $-N(R^9)COR^{10}$, $-N(R^9)C(=O)R^{10}$,
 $-N(R^9)SO_2R^{10}$, and common amino acid side chains;

R^9 and R^{10} are independently selected from:

15 H and C_{1-4} alkyl, wherein the NR⁹R¹⁰ group of R^7 , R^8 , R^{7a} , R^{8a} , R^{7b} and R^{8b} is optionally cyclized to form a 5-8 membered heterocyclic group;

J is a member selected from the group consisting of:



R^{11} is a member selected from the group consisting of:

20 hydrogen, C_{1-4} alkyl, C_{2-6} alkenyl, C_{0-4} alkylaryl and a C_{0-4} alkylheterocyclic ring;

Z is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1b} substituents;
- (b) an aromatic heterocyclic ring having from 5 to 10 ring atoms,
- 25 wherein 1-4 ring atoms are selected from N, O and S, and wherein the ring may be substituted independently by from 0-2 R^{1b} substituents;
- and

- 20 -

- (c) a fused aromatic bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, wherein the bicyclic ring system may be substituted from 0-2 R^{1b} substituents;

5 R^{1b} is selected from:

halo, C_{1-4} alkyl, OH, OBn, $O-CH_2-CH_2-OH$, $O-CH_2-CH_2-OCH_3$,
 $O-CH_2-COOH$, $O-CH_2-C(=O)-O-CH_3$, NH_2 , $NH-CH_2-CH_2-O-CH_3$,
 $NH-C(=O)-O-CH_3$, and $NH-SO_2-CH_3$;

L is selected from:

10 H , $C(=O)NR^{12}R^{13}$, $(CH_2)_nNR^{12}R^{13}$ and $C(=NR^{12})NR^{12}R^{13}$;

R^{12} and R^{13} are independently selected from:

hydrogen and C_{1-4} alkyl;

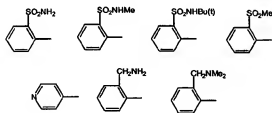
and all pharmaceutically acceptable isomers, salts, hydrates, solvates and
 15 prodrug derivatives thereof.

In a further preferred embodiment, the present invention provides a
 compound according to formula I:

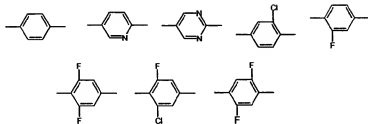
A-D-E-G-J-Z-L

Wherein:

20 A is a member selected from the group consisting of:



D is a member selected from the group consisting of:



5 E is a member selected from the group consisting of:

$-\text{C}(=\text{O})-\text{NH}-$, $-\text{C}(=\text{O})-\text{N}(\text{-CH}_3)-$, $\text{C}(=\text{O})-\text{N}(\text{-Bn})-$, $-\text{NH}-\text{C}(=\text{O})-$, $-\text{N}(\text{-CH}_3)-\text{C}(=\text{O})-$ and $-\text{N}(\text{-Bn})\text{C}(=\text{O})-$;

G is selected from:

10 $-\text{CH}(\text{-NH}_2)-\text{CH}_2-$, $-\text{CH}(\text{-NH}(\text{C}(=\text{O})-\text{CH}_3))-\text{CH}_2-$,
 $-\text{CH}(\text{-NH}(\text{C}(=\text{O})-\text{Ph}))-\text{CH}_2-$, $-\text{CH}(\text{C}(=\text{O})-\text{OR}^8)-$, $-\text{CH}(\text{-R}^7)-$,
 $-\text{CH}_2-\text{CH}(\text{C}(=\text{O})-\text{OR}^8)-$, and $-\text{CH}_2-\text{CH}(\text{C}(=\text{O})-\text{N}(\text{-R}^8, \text{-R}^8))-$;

R^7 is a member selected from the group consisting of:

H, phenyl, Bn, and cyclohexyl;

R^8 is a member selected from the group consisting of:

15 H, C_{1-6} alkyl, and C_{3-6} cycloalkyl;

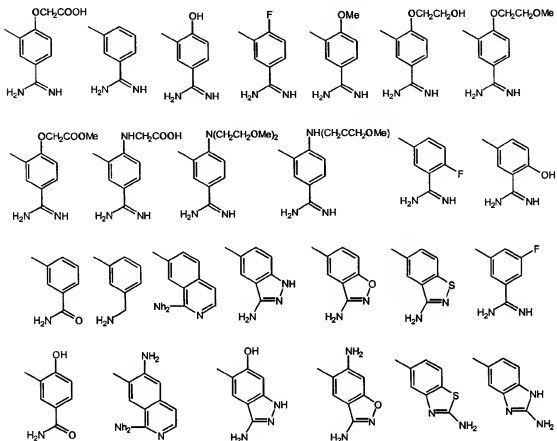
J is a member selected from the group consisting of;

$-\text{C}(=\text{O})-\text{N}(\text{R}^{11})-(\text{CH}_2)_{0-2}$, $-\text{N}(\text{R}^{11})-(\text{CH}_2)_{0-2}-\text{C}(=\text{O})-$, and $-\text{N}(\text{R}^{11})-(\text{CH}_2)_{0-2}$;

R^{11} is a member selected from the group consisting of:

H, methyl, phenyl and benzyl; and

Z and L taken together are a member selected from the group consisting of:



and all pharmaceutically acceptable isomers, salts, hydrates, solvates and

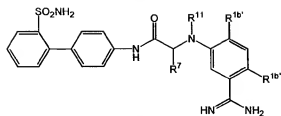
5 prodrug derivatives thereof.

The following non-limiting tables illustrate representative compounds of the present invention:

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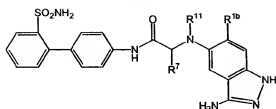
Table 1



Formula II

R ⁷	R ¹¹	R ^{1b'}	R ^{1b*}
H	H	H	H
Me	Me	H	OH
		F	H
		-OH	F
		Br	OH
		-NH2	OH
		OCH2Ph	F
		OCH2CH2OMe	H
		H	H
		H	H

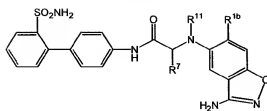
Table 2



Formula III

R ⁷	R ¹¹	R ^{1b}
H	H	H
Me	Me	H
		F
		-OH
		Br
		-NH ₂
		OCH ₂ Ph
		OCH ₂ CH ₂ OMe
		H
		H

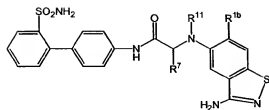
Table 3



Formula IV

R ⁷	R ¹¹	R ^{1b}
H	H	H
Me	Me	H
		F
		-OH
		Br
		-NH ₂
		OCH ₂ Ph
		OCH ₂ CH ₂ OMe
		H
		H

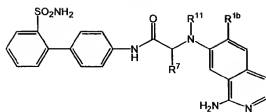
Table 4



Formula V

R ⁷	R ¹¹	R ^{1b}
H	H	H
Me	Me	H
		F
		-OH
		Br
		-NH ₂
		OCH ₂ Ph
		OCH ₂ CH ₂ OMe
		H
		H

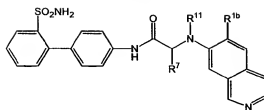
Table 5



Formula VI

R ⁷	R ¹¹	R ^{1b}
H	H	H
Me	Me	H
		F
		-OH
		Br
		-NH ₂
		OCH ₂ Ph
		OCH ₂ CH ₂ OMe
		H
		H

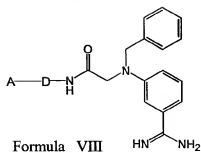
Table 6



Formula VII

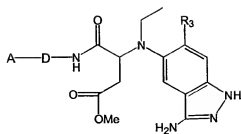
R ⁷	R ¹¹	R ^{1b}
H	H	H
Me	Me	H
		F
		-OH
		Br
		-NH ₂
		OCH ₂ Ph
		OCH ₂ CH ₂ OMe
		H
		H

Table 7



A	D	A	D

Table 8



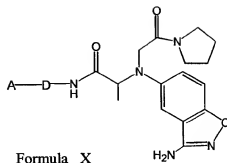
Formula IX

A	D	A	D

wherein R₃ is a member selected from the group consisting of H, F, -OH, Br,

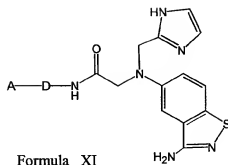
Cl, $-\text{NH}_2$, $-\text{O}-\text{CH}_2-\text{O}-\text{Ph}$ and $-\text{O}-\text{CH}_2-\text{CH}_2-\text{O}-\text{CH}_3$,

Table 9



A	D	A	D

Table 10



Formula XI

























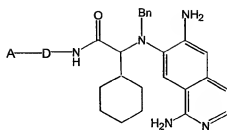
A	D	A	D
			
			
			
			
			
			

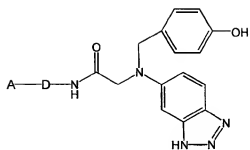
Table 11



Formula XII

A	D	A	D

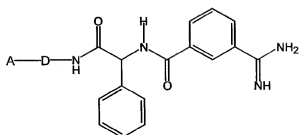
Table 12



Formula XIII

A	D	A	D

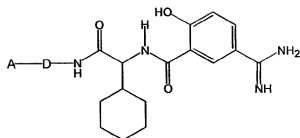
Table 13



Formula XIV

A	D	A	D

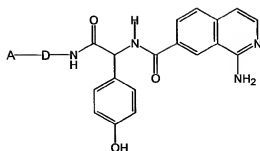
Table 14



Formula XV

A	D	A	D

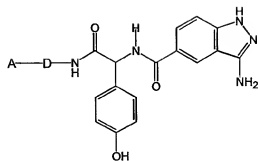
Table 15



Formula XVI

A	D	A	D

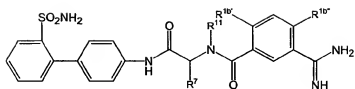
Table 16



Formula XVII

A	D	A	D

Table 17



Formula XVIII









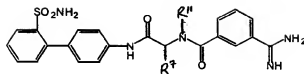
R ⁷	R ¹¹	R ^{1b'}	R ^{1b''}
H	H	H	H
Me	H	H	OH
		F	H
		-OH	F
		OH	OH
		-NH2	H

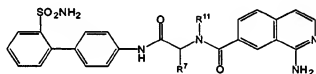
Table 18



Formula XIX

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

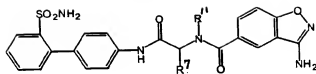
Table 19



Formula XX

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

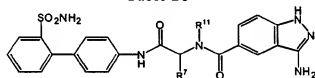
Table 20



Formula XXI

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

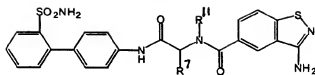
Table 21



Formula XXII

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

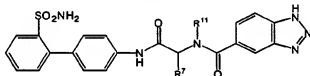
Table 22



Formula XXIII

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

Table 23

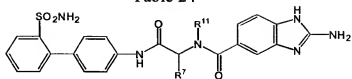


Formula XXIV

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

- 43 -

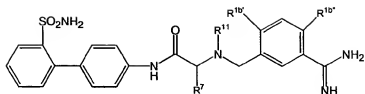
Table 24



Formula XXV

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

Table 25



Formula XXVI









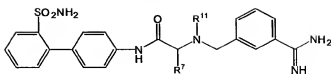
R ⁷	R ¹¹	R ^{10'}	R ^{10''}
H	H	H	H
Me	H	H	OH
		F	H
		-OH	F
		OH	OH
		-NH ₂	H

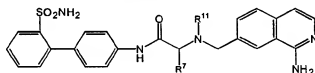
Table 26



Formula XXVII

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

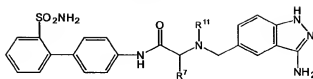
Table 27



Formula XXVIII

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

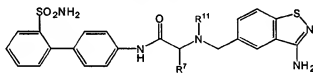
Table 28



Formula XXIX

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

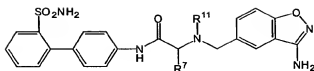
Table 29



Formula XXX

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

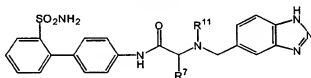
Table 30



Formula XXXI

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

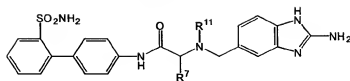
Table 31



Formula XXXII

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

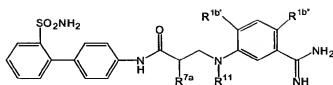
Table 32



Formula XXXIII

R ⁷	R ¹¹	R ⁷	R ¹¹
H	H		
Me	H		

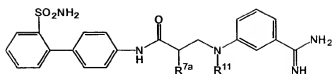
Table 33



Formula XXXIV

R ^{7a}	R ¹¹	R ^{1b'}	R ^{1b''}
H	H	H	H
Me	H	H	OH
		F	H
		-OH	F
		OH	OH
		-NH2	H
-NH2	Me	H	F
-NHAc	Me	H	H
NHSO2Me	Me	H	H

Table 34



Formula XXXV









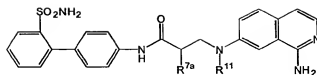
R ^{7a}	R ¹¹
H	H
Me	H
	
	
	
	
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

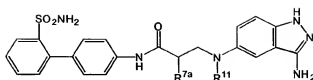
Table 35



Formula XXXVI

R ^{7a}	R ¹¹
H	H
Me	H
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

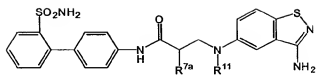
Table 36



Formula XXXVII

R^{7a}	R^{11}
H	H
Me	H
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

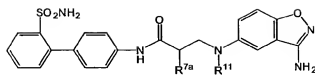
Table 37



Formula XXXVIII

R ^{7a}	R ¹¹
H	H
Me	H
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

Table 38



Formula XXIX









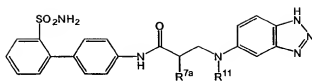
R ^{7a}	R ¹¹
H	H
Me	H
	
	
	
	
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

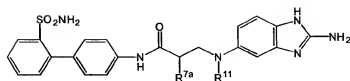
Table 39











Formula XXXX

R ^{7a}	R ¹¹
H	H
Me	H
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

Table 40

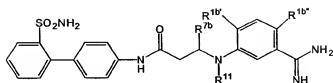


Formula XXXXI

R ^{7a}	R ¹¹
H	H
Me	H
	
	
	
	
-NH ₂	Me
-NHAc	Me
NHSO ₂ Me	Me

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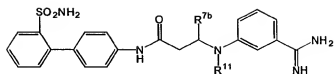
Table 41



Formula XXXXII

R ^{7b}	R ¹¹	R ^{1b'}	R ^{1b''}
H	H	H	H
-C(=O)NCH ₂ CH ₂ COCH ₃	H	H	OH
		F	H
		-OH	F
		OH	OH
		-NH ₂	H
-COOH	Me	H	F
-COOCH ₃	Me	H	H
-C(=O)N(CH ₃) ₂	Me	H	H

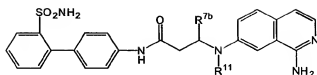
Table 42



Formula XXXXIII

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ COCH ₃	H
-COOH	Me
-COOC ₂ H ₅	Me
-C(=O)N(CH ₃) ₂	Me

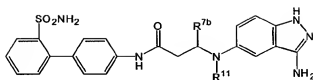
Table 43



Formula XXXIV

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ COCH ₃	H
-COOH	Me
-COOC H ₃	Me
-C(=O)N(CH ₃) ₂	Me

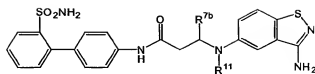
Table 44



Formula XXXXV

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ OC(=O)H ₃	H
-COOH	Me
-COOC(=O)H ₃	Me
-C(=O)N(CH ₃) ₂	Me

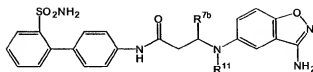
Table 45



Formula XXXXVI

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ CH ₃	H
-COOH	Me
-COOCH ₃	Me
-C(=O)N(CH ₃) ₂	Me

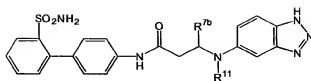
Table 46



Formula XXXXVII

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ COCH ₃	H
-COOH	Me
-COOC H ₃	Me
-C(=O)N(CH ₃) ₂	Me

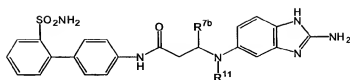
Table 47



Formula XXXXVIII

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ COCH ₃	H
-COOH	Me
-COOCH ₃	Me
-C(=O)N(CH ₃) ₂	Me

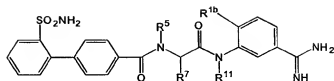
Table 48



Formula XXXIX

R ^{7b}	R ¹¹
H	H
-C(=O)NCH ₂ CH ₂ OCH ₃	H
-COOH	Me
-COOCH ₃	Me
-C(=O)N(CH ₃) ₂	Me

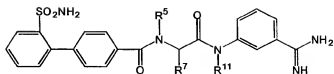
Table 49



Formula L

R ⁵	R ⁷	R ¹¹	R ^{1b}
H	H	H	H
Me	Me	H	H
		Me	F
		Bn	OH
			OMe
			OBn
H	-CH ₂ OOH		OCH ₂ COOH
Me	-CH ₂ CH ₂ COOMe		OCH ₂ CH ₂ OMe
Bn	-CH ₂ CH ₂ CONMe ₂		OH

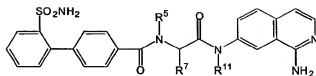
Table 50



Formula LI

R ⁵	R ⁷	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH2OOH	
Me	-CH2CH2COOMe	
Bn	-CH2CH2CONMe2	

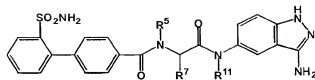
Table 51



Formula LII

R ⁵	R ⁷	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

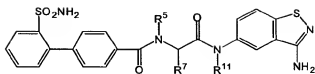
Table 52



Formula LIII

R ⁵	R ⁷	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

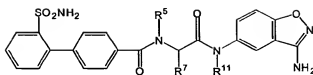
Table 53



Formula LIV

R ⁵	R ⁷	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ COOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

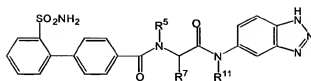
Table 54



Formula LV

R^5	R^7	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

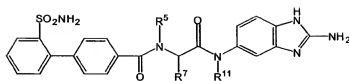
Table 55



Formula LVI

R^5	R^7	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

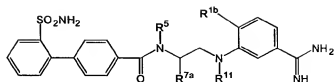
Table 56



Formula LVII

R ⁵	R ⁷	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

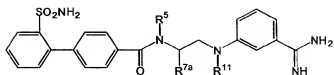
Table 57



Formula LVIII

R ⁵	R ^{7a}	R ¹¹	R ^{1b}
H	H	H	H
Me	Me	H	H
		Me	F
		Bn	OH
			OMe
			OBn
H	-CH ₂ OOH		OCH ₂ CO OH
Me	-CH ₂ CH ₂ COOMe		OCH ₂ CH ₂ OMe
Bn	-CH ₂ CH ₂ CONMe ₂		OH

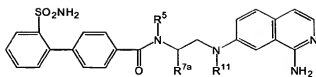
Table 58



Formula LIX

R^5	R^{7a}	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ COOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

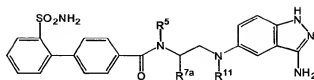
Table 59



Formula LX

R^5	R^{7a}	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH2OOH	
Me	-CH2CH2COOMe	
Bn	-CH2CH2CONMe2	

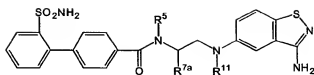
Table 60



Formula LXI

R^5	R^{7a}	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	$-\text{CH}_2\text{OOH}$	
Me	$-\text{CH}_2\text{CH}_2\text{COOMe}$	
Bn	$-\text{CH}_2\text{CH}_2\text{CONMe}_2$	

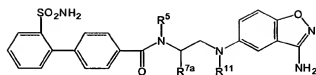
Table 61



Formula LXII

R ⁵	R ^{7a}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

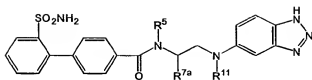
Table 62



Formula LXIII

R ⁵	R ^{7a}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

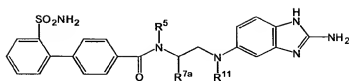
Table 63



Formula LXIV

R ⁵	R ^{7a}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

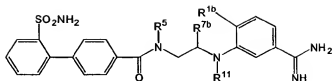
Table 64



Formula LXV

R ⁵	R ^{7a}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH2COOH	
Me	-CH2CH2COOMe	
Bn	-CH2CH2CONMe2	

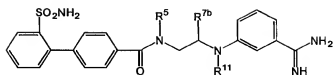
Table 65



Formula LXVI

R ⁵	R ^{7b}	R ¹¹	R ^{1b}
H	H	H	H
Me	Me	H	H
		Me	F
		Bn	OH
			OMe
			OBn
H	-CH ₂ OOH		OCH ₂ CO OH
Me	-CH ₂ CH ₂ COOMe		OCH ₂ CH ₂ OMe
Bn	-CH ₂ CH ₂ CONMe ₂		OH

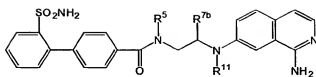
Table 66



Formula LXVII

R ⁵	R ^{7b}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ COOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

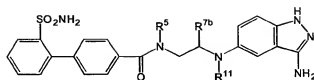
Table 67



Formula LXVIII

R^5	R^{7b}	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

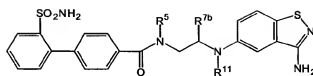
Table 68



Formula LXVIX

R ⁵	R ^{7b}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ COOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

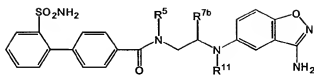
Table 69



Formula LXX

R ⁵	R ^{7b}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

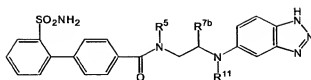
Table 70



Formula LXXI

R^5	R^{7b}	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ COOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

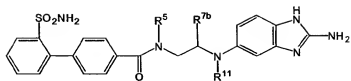
Table 71



Formula LXXII

R^5	R^{7b}	R^{11}
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ OOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

Table 72



Formula LXXIII

R ⁵	R ^{7b}	R ¹¹
H	H	H
Me	Me	H
		Me
		Bn
H	-CH ₂ COOH	
Me	-CH ₂ CH ₂ COOMe	
Bn	-CH ₂ CH ₂ CONMe ₂	

This invention also encompasses all pharmaceutically acceptable isomers, salts, hydrates and solvates of the compounds of formulas I, II and III. In addition, the compounds of formulas I, II and III can exist in various isomeric and tautomeric forms, and all such forms are meant to be included in the invention, along with
5 pharmaceutically acceptable salts, hydrates and solvates of such isomers and tautomers.

The compounds of this invention may be isolated as the free acid or base or converted to salts of various inorganic and organic acids and bases. Such salts are within the scope of this invention. Non-toxic and physiologically compatible salts
10 are particularly useful although other less desirable salts may have use in the processes of isolation and purification.

A number of methods are useful for the preparation of the salts described above and are known to those skilled in the art. For example, the free acid or free base form of a compound of one of the formulas above can be reacted with one or
15 more molar equivalents of the desired acid or base in a solvent or solvent mixture in which the salt is insoluble, or in a solvent like water after which the solvent is removed by evaporation, distillation or freeze drying. Alternatively, the free acid or base form of the product may be passed over an ion exchange resin to form the desired salt or one salt form of the product may be converted to another using the
20 same general process.

Prodrug Derivatives of Compounds

This invention also encompasses prodrug derivatives of the compounds contained herein. The term "prodrug" refers to a pharmacologically inactive derivative of a parent drug molecule that requires biotransformation, either
25 spontaneous or enzymatic, within the organism to release the active drug. Prodrugs are variations or derivatives of the compounds of this invention which have groups cleavable under metabolic conditions. Prodrugs become the compounds of the invention which are pharmaceutically active *in vivo*, when they undergo solvolysis under physiological conditions or undergo enzymatic degradation. Prodrug
30 compounds of this invention may be called single, double, triple etc., depending on the number of biotransformation steps required to release the active drug within the organism, and indicating the number of functionalities present in a precursor-type form. Prodrug forms often offer advantages of solubility, tissue compatibility, or

delayed release in the mammalian organism (see, Bundgard, Design of Prodrugs, pp. 7-9, 21-24, Elsevier, Amsterdam 1985 and Silverman, The Organic Chemistry of Drug Design and Drug Action, pp. 352-401, Academic Press, San Diego, CA, 1992). Prodrugs commonly known in the art include acid derivatives well known to practitioners of the art, such as, for example, esters prepared by reaction of the parent acids with a suitable alcohol, or amides prepared by reaction of the parent acid compound with an amine, or basic groups reacted to form an acylated base derivative. Moreover, the prodrug derivatives of this invention may be combined with other features herein taught to enhance bioavailability.

As mentioned above, the compounds of this invention find utility as therapeutic agents for disease states in mammals which have disorders of coagulation such as in the treatment or prevention of unstable angina, refractory angina, myocardial infarction, transient ischemic attacks, thrombotic stroke, embolic stroke, disseminated intravascular coagulation including the treatment of septic shock, deep venous thrombosis in the prevention of pulmonary embolism or the treatment of reocclusion or restenosis of reperfused coronary arteries. Further, these compounds are useful for the treatment or prophylaxis of those diseases which involve the production and/or action of factor Xa/prothrombinase complex. This includes a number of thrombotic and prothrombotic states in which the coagulation cascade is activated which include but are not limited to, deep venous thrombosis, pulmonary embolism, myocardial infarction, stroke, thromboembolic complications of surgery and peripheral arterial occlusion.

Accordingly, a method for preventing or treating a condition in a mammal characterized by undesired thrombosis comprises administering to the mammal a therapeutically effective amount of a compound of this invention. In addition to the disease states noted above, other diseases treatable or preventable by the administration of compounds of this invention include, without limitation, occlusive coronary thrombus formation resulting from either thrombolytic therapy or percutaneous transluminal coronary angioplasty, thrombus formation in the venous vasculature, disseminated intravascular coagulopathy, a condition wherein there is rapid consumption of coagulation factors and systemic coagulation which results in the formation of life-threatening thrombi occurring throughout the microvasculature leading to widespread organ failure, hemorrhagic stroke, renal dialysis, blood oxygenation, and cardiac catheterization.

The compounds of the invention also find utility in a method for inhibiting the coagulation biological samples, which comprises the administration of a compound of the invention.

The compounds of the present invention may also be used in combination with other therapeutic or diagnostic agents. In certain preferred embodiments, the compounds of this invention may be coadministered along with other compounds typically prescribed for these conditions according to generally accepted medical practice such as anticoagulant agents, thrombolytic agents, or other antithrombotics, including platelet aggregation inhibitors, tissue plasminogen activators, urokinase, prourokinase, streptokinase, heparin, aspirin, or warfarin. The compounds of the present invention may act in a synergistic fashion to prevent reocclusion following a successful thrombolytic therapy and/or reduce the time to reperfusion. These compounds may also allow for reduced doses of the thrombolytic agents to be used and therefore minimize potential hemorrhagic side-effects. The compounds of this invention can be utilized *in vivo*, ordinarily in mammals such as primates, (e.g. humans), sheep, horses, cattle, pigs, dogs, cats, rats and mice, or *in vitro*.

The biological properties of the compounds of the present invention can be readily characterized by methods that are well known in the art, for example by the *in vitro* protease activity assays and *in vivo* studies to evaluate antithrombotic efficacy, and effects on hemostasis and hematological parameters, such as are illustrated in the examples.

Diagnostic applications of the compounds of this invention will typically utilize formulations in the form of solutions or suspensions. In the management of thrombotic disorders the compounds of this invention may be utilized in compositions such as tablets, capsules or elixirs for oral administration, suppositories, sterile solutions or suspensions or injectable administration, and the like, or incorporated into shaped articles. Subjects in need of treatment (typically mammalian) using the compounds of this invention can be administered dosages that will provide optimal efficacy. The dose and method of administration will vary from subject to subject and be dependent upon such factors as the type of mammal being treated, its sex, weight, diet, concurrent medication, overall clinical condition, the particular compounds employed, the specific use for which these compounds are employed, and other factors which those skilled in the medical arts will recognize.

Formulations of the compounds of this invention are prepared for storage or administration by mixing the compound having a desired degree of purity with physiologically acceptable carriers, excipients, stabilizers etc., and may be provided in sustained release or timed release formulations. Acceptable carriers or diluents for therapeutic use are well known in the pharmaceutical field, and are described, for example, in Remington's Pharmaceutical Sciences, Mack Publishing Co., (A.R. Gennaro edit. 1985). Such materials are nontoxic to the recipients at the dosages and concentrations employed, and include buffers such as phosphate, citrate, acetate and other organic acid salts, antioxidants such as ascorbic acid, low molecular weight (less than about ten residues) peptides such as polyarginine, proteins, such as serum albumin, gelatin, or immunoglobulins, hydrophilic polymers such as polyvinylpyrrolidone, amino acids such as glycine, glutamic acid, aspartic acid, or arginine, monosaccharides, disaccharides, and other carbohydrates including cellulose or its derivatives, glucose, mannose or dextrins, chelating agents such as EDTA, sugar alcohols such as mannitol or sorbitol, counterions such as sodium and/or nonionic surfactants such as Tween, Pluronics or polyethyleneglycol.

Dosage formulations of the compounds of this invention to be used for therapeutic administration must be sterile. Sterility is readily accomplished by filtration through sterile membranes such as 0.2 micron membranes, or by other conventional methods. Formulations typically will be stored in lyophilized form or as an aqueous solution. The pH of the preparations of this invention typically will be 3-11, more preferably 5-9 and most preferably 7-8. It will be understood that use of certain of the foregoing excipients, carriers, or stabilizers will result in the formation of cyclic polypeptide salts. While the preferred route of administration is by injection, other methods of administration are also anticipated such as orally, intravenously (bolus and/or infusion), subcutaneously, intramuscularly, colonically, rectally, nasally, transdermally or intraperitoneally, employing a variety of dosage forms such as suppositories, implanted pellets or small cylinders, aerosols, oral dosage formulations and topical formulations such as ointments, drops and dermal patches. The compounds of this invention are desirably incorporated into shaped articles such as implants which may employ inert materials such as biodegradable polymers or synthetic silicones, for example, Silastic, silicone rubber or other polymers commercially available.

The compounds of the invention may also be administered in the form of

liposome delivery systems, such as small unilamellar vesicles, large unilamellar vesicles and multilamellar vesicles. Liposomes can be formed from a variety of lipids, such as cholesterol, stearylamine or phosphatidylcholines.

The compounds of this invention may also be delivered by the use of
5 antibodies, antibody fragments, growth factors, hormones, or other targeting moieties, to which the compound molecules are coupled. The compounds of this invention may also be coupled with suitable polymers as targetable drug carriers. Such polymers can include polyvinylpyrrolidone, pyran copolymer, polyhydroxy-
propyl-methacrylamide-phenol, polyhydroxyethyl-aspartamide-phenol, or
10 polyethyleneoxide-polylysine substituted with palmitoyl residues. Furthermore, compounds of the invention may be coupled to a class of biodegradable polymers useful in achieving controlled release of a drug, for example polylactic acid, polyglycolic acid, copolymers of polylactic and polyglycolic acid, polyeppilon caprolactone, polyhydroxy butyric acid, polyorthoesters, polyacetals,
15 polydihydropyrans, polycyanoacrylates and cross linked or amphipathic block copolymers of hydrogels. Polymers and semipermeable polymer matrices may be formed into shaped articles, such as valves, stents, tubing, prostheses and the like.

Therapeutic compound liquid formulations generally are placed into a
container having a sterile access port, for example, an intravenous solution bag or
20 vial having a stopper pierceable by hypodermic injection needle.

Therapeutically effective dosages may be determined by either *in vitro* or *in vivo* methods. For each particular compound of the present invention, individual determinations may be made to determine the optimal dosage required. The range of
25 therapeutically effective dosages will be influenced by the route of administration, the therapeutic objectives and the condition of the patient. For injection by hypodermic needle, it may be assumed the dosage is delivered into the body's fluids. For other routes of administration, the absorption efficiency must be individually determined for each compound by methods well known in pharmacology.
30 Accordingly, it may be necessary for the therapist to titer the dosage and modify the route of administration as required to obtain the optimal therapeutic effect. The determination of effective dosage levels, that is, the dosage levels necessary to achieve the desired result, will be readily determined by one skilled in the art. Typically, applications of compound are commenced at lower dosage levels, with

dosage levels being increased until the desired effect is achieved.

The compounds of the invention can be administered orally or parenterally in an effective amount within the dosage range of about 0.1 to 100 mg/kg, preferably about 0.5 to 50 mg/kg and more preferably about 1 to 20 mg/kg on a regimen in a single or 2 to 4 divided daily doses and/or continuous infusion.

Typically, about 5 to 500 mg of a compound or mixture of compounds of this invention, as the free acid or base form or as a pharmaceutically acceptable salt, is compounded with a physiologically acceptable vehicle, carrier, excipient, binder, preservative, stabilizer, dye, flavor etc., as called for by accepted pharmaceutical practice. The amount of active ingredient in these compositions is such that a suitable dosage in the range indicated is obtained.

Typical adjuvants which may be incorporated into tablets, capsules and the like are binders such as acacia, corn starch or gelatin, and excipients such as microcrystalline cellulose, disintegrating agents like corn starch or alginic acid, lubricants such as magnesium stearate, sweetening agents such as sucrose or lactose, or flavoring agents. When a dosage form is a capsule, in addition to the above materials it may also contain liquid carriers such as water, saline, or a fatty oil. Other materials of various types may be used as coatings or as modifiers of the physical form of the dosage unit. Sterile compositions for injection can be formulated according to conventional pharmaceutical practice. For example, dissolution or suspension of the active compound in a vehicle such as an oil or a synthetic fatty vehicle like ethyl oleate, or into a liposome may be desired. Buffers, preservatives, antioxidants and the like can be incorporated according to accepted pharmaceutical practice.

Preparation of Compounds

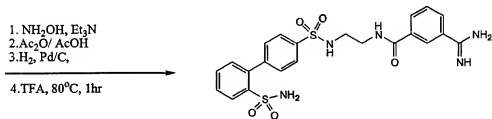
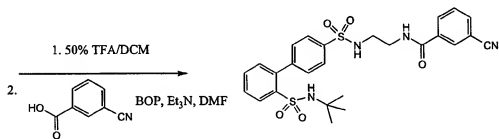
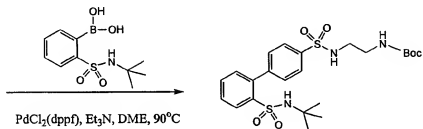
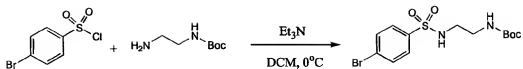
The compounds of the present invention may be synthesized by either solid or liquid phase methods described and referenced in standard textbooks, or by a combination of both methods. These methods are well known in the art. See, Bodanszky, "The Principles of Peptide Synthesis", Hafner, *et al.*, Eds., Springer-Verlag, Berlin, 1984.

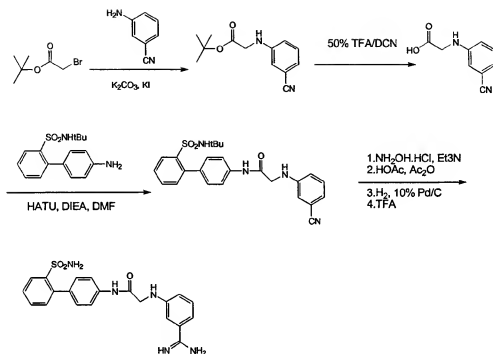
Starting materials used in any of these methods are commercially available from chemical vendors such as Aldrich, Sigma, Nova Biochemicals, Bachem Biosciences, and the like, or may be readily synthesized by known procedures.

- 5 Reactions are carried out in standard laboratory glassware and reaction vessels under reaction conditions of standard temperature and pressure, except where otherwise indicated.

- 10 During the synthesis of these compounds, the functional groups of the amino acid derivatives used in these methods are protected by blocking groups to prevent cross reaction during the coupling procedure. Examples of suitable blocking groups and their use are described in "The Peptides: Analysis, Synthesis, Biology", Academic Press, Vol. 3 (Gross, *et al.*, Eds., 1981) and Vol. 9 (1987), the disclosures of which are incorporated herein by reference.

- 15 Non-limiting exemplary synthesis schemes are outlined directly below, and specific steps are described in the Examples. The reaction products are isolated and purified by conventional methods, typically by solvent extraction into a compatible solvent. The products may be further purified by column chromatography or other
20 appropriate methods.

Scheme 1

Scheme 2Compositions and Formulations

- 5 The compounds of this invention may be isolated as the free acid or base or converted to salts of various inorganic and organic acids and bases. Such salts are within the scope of this invention. Non-toxic and physiologically compatible salts are particularly useful although other less desirable salts may have use in the processes of isolation and purification.

- 10 A number of methods are useful for the preparation of the salts described above and are known to those skilled in the art. For example, reaction of the free acid or free base form of a compound of the structures recited above with one or more molar equivalents of the desired acid or base in a solvent or solvent mixture in which the salt is insoluble, or in a solvent like water after which the solvent is

removed by evaporation, distillation or freeze drying. Alternatively, the free acid or base form of the product may be passed over an ion exchange resin to form the desired salt or one salt form of the product may be converted to another using the same general process.

- 5 Diagnostic applications of the compounds of this invention will typically utilize formulations such as solution or suspension. In the management of thrombotic disorders the compounds of this invention may be utilized in compositions such as tablets, capsules or elixirs for oral administration, suppositories, sterile solutions or suspensions or injectable administration, and the
- 10 like, or incorporated into shaped articles. Subjects in need of treatment (typically mammalian) using the compounds of this invention can be administered dosages that will provide optimal efficacy. The dose and method of administration will vary from subject to subject and be dependent upon such factors as the type of mammal being treated, its sex, weight, diet, concurrent medication, overall clinical condition,
- 15 the particular compounds employed, the specific use for which these compounds are employed, and other factors which those skilled in the medical arts will recognize.

- Formulations of the compounds of this invention are prepared for storage or administration by mixing the compound having a desired degree of purity with physiologically acceptable carriers, excipients, stabilizers etc., and may be provided
- 20 in sustained release or timed release formulations. Acceptable carriers or diluents for therapeutic use are well known in the pharmaceutical field, and are described, for example, in *Remington's Pharmaceutical Sciences*, Mack Publishing Co., (A.R. Gennaro edit. 1985). Such materials are nontoxic to the recipients at the dosages and concentrations employed, and include buffers such as phosphate, citrate, acetate
- 25 and other organic acid salts, antioxidants such as ascorbic acid, low molecular weight (less than about ten residues) peptides such as polyarginine, proteins, such as

serum albumin, gelatin, or immunoglobulins, hydrophilic polymers such as polyvinylpyrrolidinone, amino acids such as glycine, glutamic acid, aspartic acid, or arginine, monosaccharides, disaccharides, and other carbohydrates including cellulose or its derivatives, glucose, mannose or dextrans, chelating agents such as

5 EDTA, sugar alcohols such as mannitol or sorbitol, counterions such as sodium and/or nonionic surfactants such as Tween, Pluronic or polyethyleneglycol.

Dosage formulations of the compounds of this invention to be used for therapeutic administration must be sterile. Sterility is readily accomplished by filtration through sterile membranes such as 0.2 micron membranes, or by other

10 conventional methods. Formulations typically will be stored in lyophilized form or as an aqueous solution. The pH of the preparations of this invention typically will be between 3 and 11, more preferably from 5 to 9 and most preferably from 7 to 8. It will be understood that use of certain of the foregoing excipients, carriers, or stabilizers will result in the formation of cyclic polypeptide salts. While the

15 preferred route of administration is by injection, other methods of administration are also anticipated such as intravenously (bolus and/or infusion), subcutaneously, intramuscularly, colonically, rectally, nasally or intraperitoneally, employing a variety of dosage forms such as suppositories, implanted pellets or small cylinders, aerosols, oral dosage formulations and topical formulations such as ointments, drops

20 and dermal patches. The compounds of this invention are desirably incorporated into shaped articles such as implants which may employ inert materials such as biodegradable polymers or synthetic silicones, for example, Silastic, silicone rubber or other polymers commercially available.

The compounds of this invention may also be administered in the form of

25 liposome delivery systems, such as small unilamellar vesicles, large unilamellar

vesicles and multilamellar vesicles. Liposomes can be formed from a variety of lipids, such as cholesterol, stearylamine or phosphatidylcholines.

The compounds of this invention may also be delivered by the use of antibodies, antibody fragments, growth factors, hormones, or other targeting moieties, to which the compound molecules are coupled. The compounds of this invention may also be coupled with suitable polymers as targetable drug carriers. Such polymers can include polyvinylpyrrolidone, pyran copolymer, polyhydroxypropyl-methacrylamide-phenol, polyhydroxyethyl-aspartamide-phenol, or polyethyleneoxide-polylysine substituted with palmitoyl residues. Furthermore, the factor Xa inhibitors of this invention may be coupled to a class of biodegradable polymers useful in achieving controlled release of a drug, for example polylactic acid, polyglycolic acid, copolymers of polylactic and polyglycolic acid, polyepsilon caprolactone, polyhydroxy butyric acid, polyorthoesters, polyacetals, polydihydropyrans, polycyanoacrylates and cross linked or amphipathic block copolymers of hydrogels. Polymers and semipermeable polymer matrices may be formed into shaped articles, such as valves, stents, tubing, prostheses and the like.

Therapeutic compound liquid formulations generally are placed into a container having a sterile access port, for example, an intravenous solution bag or vial having a stopper pierceable by hypodermic injection needle.

Therapeutically effective dosages may be determined by either *in vitro* or *in vivo* methods. For each particular compound of the present invention, individual determinations may be made to determine the optimal dosage required. The range of therapeutically effective dosages will naturally be influenced by the route of administration, the therapeutic objectives, and the condition of the patient. For injection by hypodermic needle, it may be assumed the dosage is delivered into the

body's fluids. For other routes of administration, the absorption efficiency must be individually determined for each inhibitor by methods well known in pharmacology. Accordingly, it may be necessary for the therapist to titer the dosage and modify the route of administration as required to obtain the optimal therapeutic effect. The determination of effective dosage levels, that is, the dosage levels necessary to achieve the desired result, will be within the ambit of one skilled in the art. Typically, applications of compound are commenced at lower dosage levels, with dosage levels being increased until the desired effect is achieved.

A typical dosage might range from about 0.001 mg/kg to about 1000 mg/kg, preferably from about 0.01 mg/kg to about 100 mg/kg, and more preferably from about 0.10 mg/kg to about 20 mg/kg. Advantageously, the compounds of this invention may be administered several times daily, and other dosage regimens may also be useful.

Typically, about 0.5 to 500 mg of a compound or mixture of compounds of this invention, as the free acid or base form or as a pharmaceutically acceptable salt, is compounded with a physiologically acceptable vehicle, carrier, excipient, binder, preservative, stabilizer, dye, flavor etc., as called for by accepted pharmaceutical practice. The amount of active ingredient in these compositions is such that a suitable dosage in the range indicated is obtained.

Typical adjuvants which may be incorporated into tablets, capsules and the like are a binder such as acacia, corn starch or gelatin, and excipient such as microcrystalline cellulose, a disintegrating agent like corn starch or alginic acid, a lubricant such as magnesium stearate, a sweetening agent such as sucrose or lactose, or a flavoring agent. When a dosage form is a capsule, in addition to the above materials it may also contain a liquid carrier such as water, saline, a fatty oil. Other

materials of various types may be used as coatings or as modifiers of the physical form of the dosage unit. Sterile compositions for injection can be formulated according to conventional pharmaceutical practice. For example, dissolution or suspension of the active compound in a vehicle such as an oil or a synthetic fatty vehicle like ethyl oleate, or into a liposome may be desired. Buffers, preservatives, antioxidants and the like can be incorporated according to accepted pharmaceutical practice.

In practicing the methods of this invention, the compounds of this invention may be used alone or in combination, or in combination with other therapeutic or diagnostic agents. In certain preferred embodiments, the compounds of this inventions may be coadministered along with other compounds typically prescribed for these conditions according to generally accepted medical practice, such as anticoagulant agents, thrombolytic agents, or other antithrombotics, including platelet aggregation inhibitors, tissue plasminogen activators, urokinase, prourokinase, streptokinase, heparin, aspirin, or warfarin. The compounds of this invention can be utilized *in vivo*, ordinarily in mammals such as primates, such as humans, sheep, horses, cattle, pigs, dogs, cats, rats and mice, or *in vitro*.

The preferred compounds of the present invention are characterized by their ability to inhibit thrombus formation with acceptable effects on classical measures of coagulation parameters, platelets and platelet function, and acceptable levels of bleeding complications associated with their use. Conditions characterized by undesired thrombosis would include those involving the arterial and venous vasculature.

With respect to the coronary arterial vasculature, abnormal thrombus formation characterizes the rupture of an established atherosclerotic plaque which is

the major cause of acute myocardial infarction and unstable angina, as well as also characterizing the occlusive coronary thrombus formation resulting from either thrombolytic therapy or percutaneous transluminal coronary angioplasty (PTCA).

With respect to the venous vasculature, abnormal thrombus formation
5 characterizes the condition observed in patients undergoing major surgery in the lower extremities or the abdominal area who often suffer from thrombus formation in the venous vasculature resulting in reduced blood flow to the affected extremity and a predisposition to pulmonary embolism. Abnormal thrombus formation further characterizes disseminated intravascular coagulopathy commonly occurs within both
10 vascular systems during septic shock, certain viral infections and cancer, a condition wherein there is rapid consumption of coagulation factors and systemic coagulation which results in the formation of life-threatening thrombi occurring throughout the microvasculature leading to widespread organ failure.

The compounds of this present invention, selected and used as disclosed
15 herein, are believed to be useful for preventing or treating a condition characterized by undesired thrombosis, such as (a) the treatment or prevention of any thrombotically mediated acute coronary syndrome including myocardial infarction, unstable angina, refractory angina, occlusive coronary thrombus occurring post-thrombolytic therapy or post-coronary angioplasty, (b) the treatment or prevention of
20 any thrombotically mediated cerebrovascular syndrome including embolic stroke, thrombotic stroke or transient ischemic attacks, (c) the treatment or prevention of any thrombotic syndrome occurring in the venous system including deep venous thrombosis or pulmonary embolus occurring either spontaneously or in the setting of malignancy, surgery or trauma, (d) the treatment or prevention of any coagulopathy
25 including disseminated intravascular coagulation (including the setting of septic shock or other infection, surgery, pregnancy, trauma or malignancy and whether

- associated with multi-organ failure or not), thrombotic thrombocytopenic purpura, thromboangiitis obliterans, or thrombotic disease associated with heparin induced thrombocytopenia, (e) the treatment or prevention of thrombotic complications associated with extracorporeal circulation (e.g. renal dialysis, cardiopulmonary
- 5 bypass or other oxygenation procedure, plasmapheresis), (f) the treatment or prevention of thrombotic complications associated with instrumentation (e.g. cardiac or other intravascular catheterization, intra-aortic balloon pump, coronary stent or cardiac valve), and (g) those involved with the fitting of prosthetic devices.

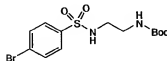
- Anticoagulant therapy is also useful to prevent coagulation of stored whole
- 10 blood and to prevent coagulation in other biological samples for testing or storage. Thus the compounds of this invention can be added to or contacted with any medium containing or suspected to contain factor Xa and in which it is desired that blood coagulation be inhibited, e.g., when contacting the mammal's blood with material such as vascular grafts, stents, orthopedic prostheses, cardiac stents, valves and
- 15 prostheses, extra corporeal circulation systems and the like.

- Without further description, it is believed that one of ordinary skill in the art can, using the preceding description and the following illustrative examples, make and utilize the compounds of the present invention and practice the claimed methods. The following working examples therefore, specifically point out
- 20 preferred embodiments of the present invention, and are not to be construed as limiting in any way the remainder of the disclosure.

EXAMPLES**Example 1**

PREPARATION OF (*tert*-butoxy)-N-[2-({[4-bromophenyl]sulfonyl}amino)ethyl]carboxamide

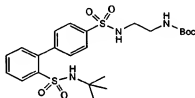
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- To a solution of N-(2-Aminoethyl)carbamic acid *tert*-butyl ester (1.86 g, 11.5 mmol) and triethyl amine (3 mL) in CH_2Cl_2 (100 mL) at 0°C , was added (4-bromophenyl)chlorosulfone (2.93 g, 11.5 mmol). The mixture was stirred for 3 hours, before the solvent was removed. The residue was dissolved in EtOAc (150 mL), washed with sat. NaHCO_3 (50 mL), sat. NaCl (50 mL), 1N HCl (50 mL), sat. NaCl (2 x 50 mL), dried over MgSO_4 , and evaporated to give 3.8 g of the title compound as a white solid in 100% yield.

Example 2

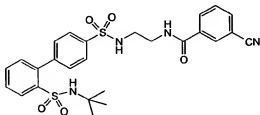
PREPARATION OF (*tert*-butoxy)-N-[2-({[4-(2-({[*tert*-butyl)amino]sulfonyl}phenyl)phenyl]sulfonyl}amino)ethyl]carboxamide



- A mixture of the compound in example 1 (380 mg, 1.0 mmol), 2-({[*tert*-butyl]amino]sulfonyl}phenyl boronic acid (308 mg, 1.2 mmol), triethyl amine (0.7 mL, 5.0 mmol), and $\text{PdCl}_2(\text{dppf})$ (40 mg, 0.05 mmol) in DME (15 mL), was heated at 90°C overnight. Upon completion of reaction, the mixture was filtered through a short plug of silica gel. The silica gel was washed with a mixture of EtOAc : Hexane (1:1), and the combined filtrate was evaporated to give 500 mg of the titled compound as a brown solid in 98% yield.

Example 3

PREPARATION OF N-[2-({[4-(2-{{(tert-butyl)amino}sulfonyl}phenyl)phenyl]sulfonyl}amino)ethyl](3-cyanophenyl)carboxamide

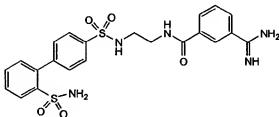


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The compound in example 2 (100 mg, 0.18 mmol) was treated with 50% TFA in CH_2Cl_2 (2 mL) at 0°C for 1 hour, before the solvent was removed by rotary evaporation. The residue, together with 3-cyanobenzoic acid (35 mg, 0.24 mmol), was dissolved in DMF (2 mL), neutralized with triethyl amine, before BOP (115 mg, 0.26 mmol) was added. The mixture was stirred at ambient temperature for two hours. Upon completion of reaction, the mixture was diluted with EtOAc (60 mL), washed with sat. NaHCO_3 (2 x 15 mL), sat. NaCl (2 x 15 mL), evaporated, and purified by HPLC to give 90 mg of the title compound.

15 **Example 4**

PREPARATION OF 3-{N-[2-({[4-(2-sulfamoylphenyl)phenyl]sulfonyl}amino)ethyl] carbamoyl}benzenecarboxamidine



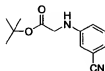
- 20 A mixture of the compound in example 3 (50 mg, 0.09 mmol), hydroxyamine hydrochloride (20 mg, 0.28 mmol), and triethyl amine (50 μL , 0.4 mmol) in EtOH (2 mL) was stirred at 45°C overnight. The solvent was removed, and the residue was dissolved in AcOH (2 mL). To this solution, acetic anhydride was added, and the mixture was stirred at ambient temperature. After stirring for 30 min, 5 mg of 10% Pd/C was added, and the mixture was subjected to 1 atmospheric hydrogen gas for 1

hour. The catalyst was filtered and the solvent was evaporated. The residue was treated with TFA (1 mL) at 80°C for 1 hour. After evaporation of TFA, the crude reaction mixture was purified by HPLC to give the title compound.

ES-MS: (M+H)⁺=502.1.

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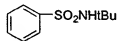
Example 5



To a solution of t-butyl bromoacetate (6.1 mL, 37.5 mmol), 3-aminobenzonitrile (2.95 g, 25 mmol), potassium carbonate (10.4 g, 75 mmol) in CH₃CN (50 mL), was added KI (0.83 g, 5 mmol). The mixture was heated to reflux for 2 hrs. The mixture was cooled to room temperature and solvent was removed in vacuo. Ether and water were added to the mixture and organic layer was washed with 2N NaOH, brine, dried over Na₂SO₄, filtered and the filtrate were concentrated *in vacuo* to give the title compound (5.7 g, 98.3%). ES-MS (M+H)⁺ = 233.1.

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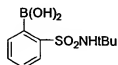
Example 6



To a solution of tert-Butylamine (41.4g, 566 mmol) and triethylamine (118 mL, 849 mmol) in DCM (1000 mL) in an ice bath, was added benzenesulfonyl chloride (100 g, 566 mmol) dropwise. The mixture was stirred at room temperature overnight. Water was added to the mixture and organic layer was washed with water, brine, dried over Na₂SO₄, filtered and filtrate evaporated *in vacuo* to give the title compound as light yellowish solid (117.63 g, 97.6%). ES-MS (M+H)⁺ = 214.1.

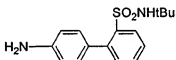
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Example 7



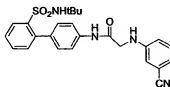
To a solution of compound of example 6 (53.25 g, 250 mmol) in THF (600 mL) in an ice bath, was added n-butyllithium in hexane (200 mL, 500 mmol) dropwise. A thick precipitate was formed when the reaction mixture was warmed up to 10°C. Triisopropylborate was added keeping the temperature below 35°C. After 1 hr., the mixture was cooled in an ice bath, 1N HCl (405 mL) was added, and the mixture was stirred overnight. The mixture was extracted with ether (100 mL) three times. The combined organic extracts were extracted with 1N NaOH (130 mL) three times. The aqueous extracts were acidified to pH 1 with 12 N HCl, and then extracted with ether three times (140 mL). The combined ether extracts were dried over MgSO₄, and solvents evaporated *in vacuo*. Hexane and ether were added and a white precipitate was formed. The solid was collected and washed with 10% ether/hexane to give the title compound. ES-MS (M+H)⁺ = 258.1.

Example 8



To a solution of compound of example 7 (6.4 g, 25 mmol) in toluene (120 mL) was added water (15 mL), 5N NaOH solution (38.5 mL), isopropanol (60 mL), 4-bromoaniline and tetrakis(triphenylphosphine)palladium(0). The mixture was refluxed for six hours, cooled to room temperature, diluted with EtOAc. The organic layer was washed with water, dried with MgSO₄, filtered and concentrated. This was purified by silica gel column chromatography using solvent system 30% EtOAc in hexane as eluent to give the title compound (5g, 66%). ES-MS M+H = 305.1.

Example 9

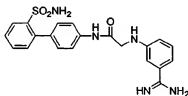


- 109 -

- The compound of example 5 (0.75 mmol) was treated with 50% TFA in DCM (4 mL). The mixture was stirred at room temperature for 30 minutes and solvent evaporated to give a white solid. This was dissolved in DMF (2 mL) and cooled to 0°C. The solution was neutralized with DIEA (0.26 mL, 1.5 mmol) followed by the addition of compound of example 8 (108 mg, 0.35 mmol) and coupling reagent HATU (285 mg, 0.75 mmol). The solution was stirred at room temperature for 15 hours. The reaction mixture was diluted in a mixture of EtOAc/H₂O (10 mL:5mL). The organic layer was washed with sat. NaHCO₃ (2 X 10 mL), sat. NaCl (2 X 10 mL), dried over MgSO₄, filtered and solvent evaporated to give the crude product.
- This was purified by silica gel column chromatography using solvent system 50% EtOAc in hexane as eluent to give the title compound (60 mg, 37.2%). ES-MS (M+Na)⁺= 485.1.

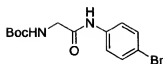
Example 10

15

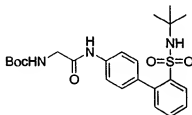


- A solution of the compound of example 9 (60 mg, 0.13 mmol), hydroxylamine hydrochloride (18.1mg, 0.26 mmol), TEA (54.3 μ L, 0.39 mmol) in absolute ethanol (4 mL) was heated up to 60°C and stirred for 15 hrs. The solution was cooled and solvent evaporated. The residue was dissolved in AcOH (2 mL). Ac₂O (49 μ L, 0.52 mmol) was added. The mixture was stirred at room temperature for 50 min. and the solvent evaporated. The residue was dissolved in MeOH (2-3 mL) and 10% Pd/C (catalytic amount) was added. The mixture was hydrogenated under balloon overnight, filtered through Celite to remove the catalyst and the filtrate was evaporated. TFA (2-3 mL) was added to the residue and the mixture was stirred at room temperature for 2-3 hrs. TFA was removed under reduced pressure to give the crude product. The obtained residue was purified by RP-HPLC to give the title compound as a white powder. ES-MS (M+H)⁺ = 424.1.

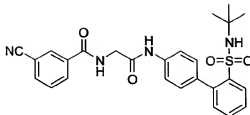
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Example 11

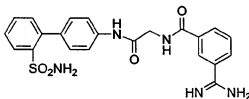
- Boc-Gly-OH (1.75 g, 10 mmol) and 4-bromoaniline (1.89 g, 11 mmol) were dissolved in DMF (25 mL). DIEA (3.48 mL, 20 mmol) was added followed by the addition of the coupling reagent BOP (4.87 g, 11 mmol). The solution was stirred at room temperature for 12 hours. The reaction mixture was diluted in a mixture of EtOAc/H₂O (100 mL:40 mL). The organic layer was washed with water, saturated Na₂CO₃, water, 1M KHSO₄, brine, dried over MgSO₄, filtered and solvent evaporated to give the title compound (1.123g, 34%). ES-MS (M+Na)⁺ = 353.

Example 12

- A mixture of compound of example 11 (328 mg, 1 mmol) and 2-(*t*-butylamino)sulfonyl-phenylboronic acid (262 mg, 1.02 mmol), tetrakis(triphenylphosphine)palladium(0) (58 mg, 0.05mmol), tetrabutylammonium bromide (16 mg, 0.05 mmol) , and potassium carbonate (147 mg, 2.13 mmol in 0.64 mL water) were refluxed with toluene (6 mL) under N₂ for 6h. The toluene was removed *in vacuo* and the residue was dissolved in methylene chloride and water. The two phases were separated and organic phase was washed with water and brine, dried over MgSO₄ and concentrated to give the title compound (445 mg, 96.5%). (M+H)⁺ = 462.1.

Example 13

- The compound of example 12 (386 mg, 0.84 mmol) was treated with 50% TFA in DCM (2 mL). The mixture was stirred at room temperature for 30 minutes then solvent evaporated to give a white solid. This was dissolved in DMF (5 mL) and cooled to 0°C. The solution was neutralized with DIEA (0.44 mL, 2.52 mmol) followed by addition of 3-cyano-benzoic acid (147 mg, 1 mmol) and coupling reagent BOP (442.5 mg, 1 mmol). The solution was stirred at room temperature for 15 hours. The reaction mixture was diluted in a mixture of EtOAc/H₂O (10 mL:5mL). The organic layer was washed with sat. NaHCO₃ (2 X 20 mL), sat. NaCl (2 X 20 mL), dried over MgSO₄, filtered and solvent evaporated to give the crude product. This was purified by silica gel column chromatography using solvent system 50% EtOAc in hexane as eluent to give the title compound (148 mg, 30%).
- ES-MS (M+Na)⁺ = 513.

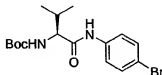
Example 14

- A solution of the compound of example 13 (61.3 mg, 0.125 mmol), hydroxylamine hydrochloride (17.4mg, 0.25 mmol), TEA (52 µL, 0.375 mmol) in absolute ethanol (4 mL) was heated up to 60°C and stirred for 15 hrs. The solution was cooled and solvent evaporated. The residue was dissolved in AcOH (2 mL). Ac₂O (47 µL, 0.5 mmol) was added. The mixture was stirred at room temperature for 50 min. and the solvent evaporated. The residue was dissolved in MeOH (2-3 mL) and 10% Pd/C (catalytic amount) was added. The mixture was hydrogenated under balloon overnight, filtered through Celite to remove the catalyst and the filtrate was

evaporated. TFA (2-3 mL) was added to the residue and the mixture was stirred at room temperature for 2-3 hrs. TFA was removed under reduced pressure to give the crude product. The obtained residue was purified by RP-HPLC to give the title compound as a white powder. ES-MS (M+H)⁺ = 452.1.

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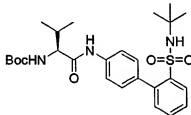
Example 15



- Boc-Val-OH (2.17 g, 10 mmol) and 4-bromoaniline (1.89 g, 11 mmol) were dissolved in DMF (25 mL). DIEA (3.48 mL, 20 mmol) was added followed by the addition of the coupling reagent BOP (4.87 g, 11 mmol). The solution was stirred at room temperature for 12 hours. The reaction mixture was diluted in a mixture of EtOAc/H₂O (100 mL:40 mL). The organic layer was washed with water, sat. Na₂CO₃, water, 1M KHSO₄, brine, dried over MgSO₄, filtered and solvent
- evaporated to give the title compound (3.53g, 95.4%). ES-MS (M+H)⁺ = 371.

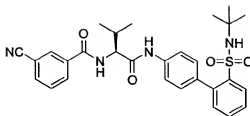
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Example 16



- A mixture of compound of example 15 (740 mg, 2 mmol) and 2-(*t*-butylamino)-sulfonyl-phenylboronic acid (616 mg, 2.4 mmol), tetrakis(triphenylphosphine)palladium(0) (115.5 mg, 0.1 mmol), tetrabutylammonium bromide (32.2 mg, 0.1 mmol), and potassium carbonate (691 mg, 5 mmol in 1.5 mL water) were refluxed with toluene (12 mL) under N₂ for 6h. The toluene was removed *in vacuo* and the residue was dissolved in methylene chloride and water. The two phases were separated and organic phase was washed with water and brine, dried over MgSO₄ and concentrated to give the title compound (1.156g, 100%). (M+H)⁺ = 504.1.

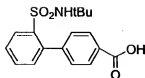
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Example 17

- The compound of example 16 (0.7 mmol) was treated with 50% TFA in DCM (2 mL). The mixture was stirred at room temperature for 30 minutes then solvent evaporated to give a white solid. This was dissolved in DMF (2 mL) and cooled to 0°C. The solution was neutralized with DIEA (0.37 mL, 2.1 mmol) followed by addition of 3-cyano-benzoic acid (124 mg, 0.84 mmol) and coupling reagent BOP (371.7 mg, 0.84 mmol). The solution was stirred at room temperature for 15 hours.
- The reaction mixture was diluted in a mixture of EtOAc/H₂O (10 mL:5mL). The organic layer was washed with sat. NaHCO₃ (2 X 20 mL), sat. NaCl (2 X 20 mL), dried over MgSO₄, filtered and solvent evaporated to give the crude product. This was purified by silica gel column chromatography using solvent system 40% EtOAc in hexane as eluent to give the title compound (204 mg, 55%). ES-MS (M+Na)+ = 555.2.

Example 18

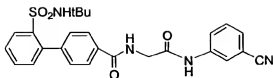
- To a solution of 2-bromobenzenesulfonyl chloride (2.951 g, 0.0115 mol), t-butylamine (1.2 mL, 0.0138 mol), and triethylamine (3.2 mL, 0.023 mol) in CH₂Cl₂ (10 mL) was stirred at 0°C. under argon for 6 h. The reaction mixture was diluted with CH₂Cl₂ (100 mL) washed with saturated NaHCO₃, and saturated NaCl. The CH₂Cl₂ layer was dried over anhydrous MgSO₄, filtered and concentrated. The crude product was dried *in vacuo* to give 3.1 g of a white solid as the title compound (92.3%).

Example 19

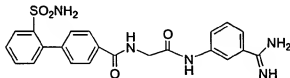
The mixture of the compound of Example 18 (4.995 g, 0.017 mol), 4-carboxyphenylboronic acid (7 g, 0.0427 mol), palladium acetate (0.095 g, 0.0425 mmol), potassium carbonate (5.87 g, 0.0425 mol), and tetrabutylammonium bromide (5.48 g, 0.017 mol) was purged under argon for 5 min. Water (60mL) was added. The reaction mixture was heated to 85 °C. and stirred under argon for 1 day. The resulting mixture was cooled to room temperature, filtered through celite and extracted with EtOAc. The EtOAc layers were combined, dried over anhydrous MgSO₄, filtered and concentrated to give 9.93 g crude product as the titled compound in quantitative yield. The purity was satisfactory for the next step.

Example 20

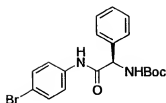
To a solution of 3-aminobenzonitrile (5 g, 0.042 mol) and Boc-gly-OH (7.4 g, 0.042 mol) in DMF (15 mL) was added DIEA (11 mL, 0.063 mol), followed by BOP (22.3 g, 0.05 mol). The reaction mixture was stirred at room temperature overnight, diluted with EtOAc (100 mL), washed with saturated NaHCO₃, and saturated NaCl. The EtOAc layer was dried over MgSO₄, filtered and concentrated to give a white solid compound in quantitative yield. This crude product was dissolved in CH₂Cl₂ (30 mL), followed by the addition of TFA (10 mL). The reaction mixture was stirred at room temperature overnight, concentrated to give the title compound as a white solid in quantitative yield (7.35 g). The purity was satisfactory for the next step.

Example 21

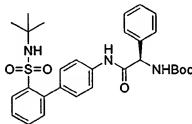
- To a solution of the compound of Example 20 (800 mg, 4.57 mmol), and the
5 compound of Example 19 (1.52 g, 4.57 mmol) in DMF (3 mL) was added DIEA
(1.18 mL, 6.86 mmol), followed by BOP (2.42 g, 5.48 mmol). The reaction mixture
was stirred at room temperature overnight, diluted with EtOAc (100 mL), washed
with saturated NaHCO₃, and saturated NaCl. The EtOAc layer was dried over
MgSO₄, filtered and concentrated to give the title compound as a white solid (2.12 g,
10 94.6%). ES-MS (M+H-tBu)⁺ = 435.0.

Example 22

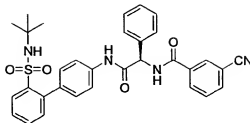
- 15 To the solution of the compound of example 21 (2.1 g, 4.3 mmol) in absolute EtOH
(25 mL) was added hydroxylamine hydrochloride (0.598 g, 8.6 mmol) and triethyl
amine (2 mL, 12.9 mmol). The reaction was stirred at 50°C overnight, concentrated
and purified via preparative HPLC to give the white solid hydroxyamidine
20 compound. It was dissolved in acetic acid (10 mL), followed by the addition of
acetic anhydride (0.5 mL). The reaction was completed in one hour and the product
concentrated to dryness. The resulting solid was dissolved in anhydrous MeOH (4
mL). Palladium (10% Wt. On activated carbon, 20 mg) was added. The reaction
mixture was stirred at room temperature under hydrogen (1 atm) for 4 hours, filtered
25 through celite and concentrated to give a pale yellow residue. It was dissolved in
TFA, stirred for 5 hours, concentrated and purified by preparative HPLC to give the
title compound as a white solid (0.28 g, 15% overall yield). ES-MS (M+H)⁺ =
452.1.

Example 23

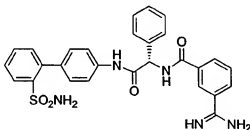
- 5 Boc-Phe-OH (1.19 g, 4.73 mmol) and 4-bromoaniline (0.895 g, 5.2 mmol) were dissolved in DMF (25 mL). DIEA (1.65 mL, 9.46 mmol) was added followed by the addition of the coupling reagent BOP (2.3 g, 5.2 mmol). The solution was stirred at room temperature for 12 hours. The reaction mixture was diluted in a mixture of EtOAc/H₂O (100 mL:40 mL). The organic layer was washed with water, sat. Na₂CO₃, water, 1M KHSO₄, brine, dried over MgSO₄, filtered and solvent
- 10 evaporated to give the title compound. ES-MS (M+H)⁺ = 405.

Example 24

- 15 A mixture of compound of example 23 (472 mg, 1.17 mmol) and 2-(t-butylamino)sulfonyl-phenylboronic acid (359.5 mg, 1.4 mmol), tetrakis(triphenylphosphine)palladium(0) (67.6 mg, 0.0585 mmol), tetrabutylammonium bromide (18.9 mg, 0.0585 mmol), and potassium carbonate (404 mg, 2.93 mmol in 0.88 mL water) were refluxed with toluene (6 mL) under N₂
- 20 for 6 hrs. The toluene was removed *in vacuo* and the residue was dissolved in methylene chloride and water. The two phases were separated and organic phase was washed with water and brine, dried over MgSO₄ and concentrated to give the title compound (435 mg, 69.2%). (M+H)⁺ = 538.1.

Example 25

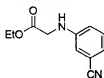
- 5 The compound of example 24 (362 mg, 0.67 mmol) was treated with 50% TFA in DCM (2 mL). The mixture was stirred at room temperature for 30 minutes then solvent evaporated to give a white solid. This was dissolved in DMF (5 mL) and cooled to 0°C. The solution was neutralized with DIEA (0.35 mL, 2.02 mmol) followed by addition of 3-CN-benzoic acid (119 mg, 0.81 mmol) and coupling
- 10 reagent BOP (358 mg, 0.81 mmol). The solution was stirred at room temperature for 15 hours. The reaction mixture was diluted in a mixture of EtOAc/H₂O (10 mL:5mL). The organic layer was washed with sat. NaHCO₃ (2 X 20 mL), sat. NaCl (2 X 20 mL), dried over MgSO₄, filtered and solvent evaporated to give the crude product. This was purified by silica gel column chromatography using solvent
- 15 system 40% EtOAc in hexane as eluent to give the title compound (137 mg, 36%). ES-MS (M+Na)⁺ = 589.

Example 26

- 20 A solution of the compound of example 25 (36.9 mg, 0.065 mmol), hydroxylamine hydrochloride (9 mg, 0.13 mmol), TEA (27 μ L, 0.20 mmol) in absolute ethanol (4 mL) was heated up to 60°C and stirred at room temperature for 15 hrs. The solution was cooled and solvent evaporated. The residue was dissolved in AcOH (2 mL). Ac₂O (24.5 μ L, 0.26 mmol) was added. The mixture was stirred at room temperature for 50 min. and the solvent evaporated. The residue was dissolved in MeOH (2-3

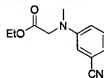
mL) and 10% Pd/C (catalytic amount) was added. The mixture was hydrogenated under balloon overnight, filtered through Celite to remove the catalyst and the filtrate was evaporated. TFA (2-3 mL) was added to the residue and the mixture was stirred at room temperature for 2-3 hrs. TFA was removed under reduced pressure to give the crude product. The obtained residue was purified by RP-HPLC to give the title compound as a white powder. ES-MS (M+H)⁺ = 528.1.

Example 27

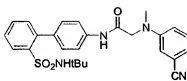


To a solution of ethyl bromoacetate (10.6g, 60mmol), 3-aminobenzonitrile (5g, 40mmol), and potassium carbonate (17.5g, 120mmol) in acetonitrile (30ml) was added potassium iodide (1.4g, 8mmol). The mixture was heated to reflux for 6 hrs. The mixture was cooled to room temperature, and solvent was removed *in vacuo*. Ether and water were added to the mixture. Organic layer was washed with 1N hydrochloride and brine, and dried over magnesium sulfate. After the concentration *in vacuo*, the crude residue was purified by silica gel column chromatography using solvent system 15% ethyl acetate in hexane as eluent to give the title compound as light yellowish solid (7.94g, 97%). ES-MS (M+H)⁺ = 205.

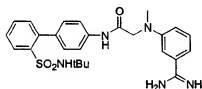
Example 28



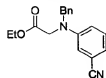
To a solution of the compound of example 27 (200mg, 1mmol) and cesium carbonate (650mg, 2mmol) in dimethylformamide (5ml) was added iodomethane (75ul, 1.2mmol). The mixture was stirred at 90 °C for 2 hrs. After the filtration of the solid, the filtrate was concentrated *in vacuo*, and the residue was purified by silica gel column chromatography using solvent system 15% ethyl acetate in hexane as eluent to give the title compound as an oil (270mg, 100%). ES-MS (M+H)⁺ = 219.

Example 29

- To a solution of the compound of example 19 (126mg, 0.41mmol) in
5 dichloromethane (5ml) was added 2.0M trimethylaluminum in hexane (0.62ml, 1.24mmol). The mixture was stirred at room temperature for 30 minutes, methane gas evolved. A solution of the compound of example 28 (90mg, 0.41mmol) in dichloromethane (1ml) was added. The mixture was stirred at room temperature overnight. 1N hydrochloride was added to acidify the solution to pH=2. After the
10 addition of water and dichloromethane, the organic layer was separated and the aqueous layer was extracted with dichloromethane. The combined organic extracts were dried over magnesium sulfate, and concentrated *in vacuo*. The crude residue was purified by silica gel column chromatography using solvent system 30% ethyl acetate in hexane as eluent to give the title compound as a solid (70mg, 36%). ES-
15 MS (M+H)+ = 477.

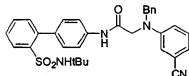
Example 30

- 20 A solution of the compound of example 29 (70mg, 0.15mmol), hydroxylamine hydrochloride (26mg, 0.37mmol) and triethylamine (52ul, 0.37mmol) in absolute ethanol (3ml) was stirred at 40 °C for 15 hrs. After the evaporation of the solvent *in vacuo*, the residue was dissolved in acetic acid (3ml), and acetic anhydride (28ul,
25 0.3mmol) was added. The mixture was stirred at room temperature for 3 hrs. It was diluted with absolute methanol (5ml), and 10% Pd/C (catalytic amount) was added. The mixture was applied with 50psi hydrogen for 6 hrs. After the filtration through Celite to remove the catalyst, the filtrate was concentrated *in vacuo*. The crude residue was purified by RP-HPLC to give the title compound as a white powder. ES-
30 MS (M+H)+ = 494.

Example 31

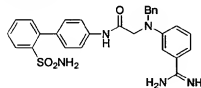
- To a solution of the compound of example 27 (200mg, 1mmol) and cesium carbonate (650mg, 2mmol) in dimethylformamide (5ml) was added benzyl bromide (180ul, 1.5mmol). The mixture was stirred at 90 °C for 2 hrs. After the filtration of the solid, the filtrate was concentrated *in vacuo* and the residue was purified by silica gel column chromatography using solvent system 10% ethyl acetate in hexane as eluent to give the title compound as an oil (210mg, 71%). ES-MS (M+H)+ = 295.

10

Example 32

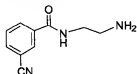
- To a solution of the compound of example 19 (126mg, 0.41mmol) in dichloromethane (5ml) was added 2.0M trimethylaluminum in hexane (0.62ml, 1.24mmol). The mixture was stirred at room temperature for 30 minutes, methane gas evolved. A solution of the compound of example 31 (120mg, 0.41mmol) in dichloromethane (1ml) was added. The mixture was stirred at room temperature overnight. 1N hydrochloride was added to acidify the solution to pH=2. After the addition of water and dichloromethane, the organic layer was separated, and the aqueous layer was extracted with dichloromethane. The combined organic extracts were dried over magnesium sulfate, and concentrated *in vacuo*. The crude residue was purified by silica gel column chromatography using solvent system 20% ethyl acetate in hexane as eluent to give the title compound as a solid (172mg, 76%). ES-MS (M+H)+ = 553.

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Example 33

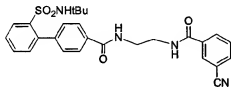
- To a solution of the compound of example 32 (100mg, 0.18mmol) and absolute methanol (73ul, 1.8mmol) in ethyl acetate (3ml) in an ice bath was saturated with hydrochloride gas for 10 minutes. The mixture was stirred at room temperature for 3 hrs. After the evaporation of the solvent *in vacuo*, the residue was dissolved in absolute methanol (3ml), and ammonia acetate (83mg, 1.08mmol) was added. The mixture was refluxed for 3 hrs. The solvent was evaporated *in vacuo*. The crude residue was purified by RP-HPLC to give the title compound as white powder. ES-MS (M+H)⁺ = 514.

10 Example 34

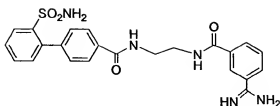


- To a solution of t-Butyl N-(aminoethyl)-carbamate (250 mg, 1.56 mmol), and 4-cyanobenzoyl chloride (258 mg, 1.56 mmol) in CH₂Cl₂ was added triethylamine (0.685 mL, 4.68 mmol). The reaction mixture was stirred at room temperature overnight. Concentration under reduced pressure gave a white solid. To the suspension of this solid compound in CH₂Cl₂ (10 mL) was added trifluoroacetic acid (5 mL), the reaction was completed after 4 hours at room temperature. The title compound was obtained in quantitative yield as a white solid after removal of the solvent and excess TFA..

20 Example 35



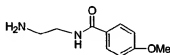
- To a solution of the compound of example 19 (518.5 mg, 1.56 mmol) and the compound of example 34 (295 mg, 1.56 mmol) in DMF (5 mL) was added DIEA (0.4 mL, 2.34 mmol), followed by BOP (828 mg, 1.87 mmol). The reaction mixture was stirred at room temperature under argon overnight. The reaction mixture was diluted with EtOAc (100 mL), washed with saturated NaHCO₃, and saturated NaCl.
- 30 The EtOAc layer was dried over anhydrous MgSO₄, filtered and concentrated to give the crude title compound in quantitative yield.

Example 36

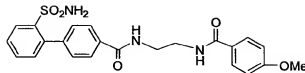
- 5 The solution of the compound of example 35 (1.24 g, theoretical 1.56 mmol) in anhydrous MeOH (10 mL) was bubbled in HCl gas for 10 minutes at 0°C. The reaction flask as capped and stirred at room temperature overnight. The mixture was concentrated to dryness. To the resulting residue in anhydrous MeOH (5 mL) was added ammonium acetate 1.2 g, 15.6 mmol). The reaction mixture was heated at
- 10 refluxing temperature for 5 hours, concentrated and purified via preparative HPLC to give the title compound as a white solid (96.4%). ES-MS (M+H)+ = 466.1.

Example 37

15



- To a solution of t-Butyl N-(aminoethyl)-carbamate (277 mg, 1.73 mmol), and 4-methoxybenzoic acid (263 mg, 1.73 mmol) in DMF (3 mL) was added DIEA (0.452 mL, 2.6 mmol). The reaction mixture was stirred at room temperature overnight,
- 20 diluted with EtOAc (100 mL), washed with saturated NaHCO₃, and saturated NaCl. The EtOAc layer was dried over anhydrous MgSO₄, filtered and concentrated to give a white solid. To the solution of this solid compound in CH₂Cl₂ (10 mL) was added TFA (10 mL). The reaction was complete after stirring at room temperature overnight. The title compound was obtained in quantitative yield (100%) after
- 25 removal of the solvent and excess TFA.

Example 38

- The solution of the compound of example 19 (1.86 g, 0.56 mmol) and the compound of example 37 (0.11 g, 0.56 mmol) in DMF (5 mL) was added DIEA (0.15 mL, 0.84 mmol), followed by BOP (0.3 g, 0.67 mmol). The reaction solution was diluted with EtOAc (100 mL), washed with saturated NaHCO_3 , and saturated NaCl. The EtOAc layer was dried over anhydrous MgSO_4 , filtered, concentrated and purified via preparative HPLC to give a white solid. It was dissolved in TFA (2 mL). The resulting was stirred at room temperature overnight, concentrated and purified via preparative HPLC to give 59.6 mg of the title compound as a white solid (24%). ES-MS ($\text{M}+\text{H}$) $^+$ = 454.1.

BIOLOGICAL ACTIVITY EXAMPLES

- Evaluation of the compounds of this invention is guided by in vitro protease activity assays (see below) and in vivo studies to evaluate antithrombotic efficacy, and effects on hemostasis and hematological parameters.

- The compounds of the present invention are dissolved in buffer to give solutions containing concentrations such that assay concentrations range from 0 to 100 μM . In the assays for thrombin, prothrombinase and factor Xa, a synthetic chromogenic substrate is added to a solution containing test compound and the enzyme of interest and the residual catalytic activity of that enzyme is determined spectrophotometrically. The IC_{50} of a compound is determined from the substrate turnover. The IC_{50} is the concentration of test compound giving 50% inhibition of the substrate turnover. The compounds of the present invention desirably have an IC_{50} of less than 500 nM in the factor Xa assay, preferably less than 200 nM, and more preferred compounds have an IC_{50} of about 100 nM or less in the factor Xa assay. The compounds of the present invention desirably have an IC_{50} of less than

- 4.0 μM in the prothrombinase assay, preferably less than 200 nM, and more preferred compounds have an IC_{50} of about 10 nM or less in the prothrombinase assay. The compounds of the present invention desirably have an IC_{50} of greater than 1.0 μM in the thrombin assay, preferably greater than 10.0 μM , and more preferred compounds have an IC_{50} of greater than 100.0 μM in the thrombin assay.

Amidolytic Assays for determining protease inhibition activity

- The factor Xa and thrombin assays are performed at room temperature, in 0.02 M Tris-HCl buffer, pH 7.5, containing 0.15 M NaCl. The rates of hydrolysis of the para-nitroanilide substrate S-2765 (Chromogenix) for factor Xa, and the substrate Chromozym TH (Boehringer Mannheim) for thrombin following preincubation of the enzyme with inhibitor for 5 minutes at room temperature, and were determined using the Softmax 96-well plate reader (Molecular Devices), monitored at 405 nm to measure the time dependent appearance of p-nitroaniline.

- The prothrombinase inhibition assay is performed in a plasma free system with modifications to the method described by Sinha, U. *et al.*, Thromb. Res., **25**, 427-436 (1994). Specifically, the activity of the prothrombinase complex is determined by measuring the time course of thrombin generation using the p-nitroanilide substrate Chromozym TH. The assay consists of preincubation (5 minutes) of selected compounds to be tested as inhibitors with the complex formed from factor Xa (0.5 nM), factor Va (2 nM), phosphatidyl serine:phosphatidyl choline (25:75, 20 μM) in 20 mM Tris-HCl buffer, pH 7.5, containing 0.15 M NaCl, 5 mM CaCl_2 and 0.1% bovine serum albumin. Aliquots from the complex-inhibitor mixture are added to prothrombin (1 nM) and Chromozym TH (0.1 mM). The rate of substrate cleavage is monitored at 405 nm for two minutes. Eight different concentrations of inhibitor are assayed in duplicate. A standard curve of thrombin

generation by an equivalent amount of untreated complex are used for determination of percent inhibition.

Antithrombotic Efficacy in a Rabbit Model of Venous Thrombosis

A rabbit deep vein thrombosis model as described by Hollenbach, S. et al.,
5 Thromb. Haemost. 71, 357-362 (1994), is used to determine the in-vivo antithrombotic activity of the test compounds. Rabbits are anesthetized with I.M. injections of Ketamine, Xylazine, and Acepromazine cocktail. A standardized protocol consists of insertion of a thrombogenic cotton thread and copper wire apparatus into the abdominal vena cava of the anesthetized rabbit. A non-occlusive thrombus is allowed to develop in the central
10 venous circulation and inhibition of thrombus growth is used as a measure of the antithrombotic activity of the studied compounds. Test agents or control saline are administered through a marginal ear vein catheter. A femoral vein catheter is used for blood sampling prior to and during steady state infusion of test compound. Initiation of thrombus formation begins immediately after advancement of the cotton thread apparatus
15 into the central venous circulation. Test compounds are administered from time = 30 min to time = 150 min at which the experiment is terminated. The rabbits are euthanized and the thrombus excised by surgical dissection and characterized by weight and histology. Blood samples are analyzed for changes in hematological and coagulation parameters.

Effects of Compounds in Rabbit Venous Thrombosis model

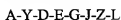
20 Administration of compounds in the rabbit venous thrombosis model demonstrates antithrombotic efficacy at the higher doses evaluated. There are no significant effects of the compound on the aPTT and PT prolongation with the highest dose (100 µg/kg + 2.57 µg/kg/min). Compounds have no significant effects on hematological parameters as compared to saline controls. All measurements are an average of all samples after steady

state administration of vehicle or (D)-Arg-Gly-Arg-thiazole. Values are expressed as mean \pm SD.

- Without further description, it is believed that one of ordinary skill in the art can, using the preceding description and the following illustrative examples, make and utilize
- 5 the compounds of the present invention and practice the claimed methods.

WHAT IS CLAIMED IS:

1. A compound according to the formula I:



5 wherein:

A is selected from:

- (a) C_1-C_6 -alkyl;
- (b) C_3-C_6 -cycloalkyl;
- (c) phenyl, which is independently substituted with 0-2 R^1 substituents;
- 10 (d) naphthyl, which is independently substituted with 0-2 R^1 substituents; and
- (e) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be
- 15 substituted from 0-2 R^1 substituents;

R^1 is selected from:

- Halo, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, -CN, -NO₂, $(CH_2)_mNR^2R^3$, $SO_2NR^2R^3$, SO_2R^2 , CF_3 , OR^2 , and a 5-6 membered aromatic heterocyclic system containing from 1-4 heteroatoms selected from N, O and S, wherein from 1-4 hydrogen atoms on the aromatic heterocyclic system may be independently replaced with a member selected from the group consisting of halo, C_1-C_4 alkyl, -CN C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl and -NO₂;

R^2 and R^3 are independently selected from the group consisting of:

- 25 H, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, C_{6-4} alkylphenyl and C_{6-4} alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{6-4} alkyl C_{3-8} cycloalkyl, -CN, and
- 30 -NO₂;

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m is an integer of 0-2;

Y is a member selected from the group consisting of:

a direct link, -C(=O)-, -N(R⁴)-, -C(=O)-N(R⁴)-, -N(R⁴)-C(=O)-, -SO₂-, -O-,
-SO₂-N(R⁴)- and -N(R⁴)-SO₂-;

5 R⁴ is selected from:

H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl,
C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on
the ring atoms of the phenyl and naphthyl moieties may be independently
replaced with a member selected from the group consisting of halo, C₁₋₄alkyl,
10 C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN, and
-NO₂.

D is a direct link or is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1a} substituents;
- (b) naphthyl, which is independently substituted with 0-2 R^{1a}
15 substituents; and
- (c) a monocyclic or fused bicyclic heterocyclic ring system having from
5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are
selected from N, O and S, and wherein the ring system may be
substituted from 0-2 R^{1a} substituents;

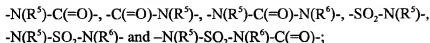
20 R^{1a} is selected from:

Halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈
cycloalkyl, -CN, -NO₂, (CH₂)_mNR^{2a}R^{3a}, SO₂NR^{2a}R^{3a}, SO₂R^{2a}, CF₃, OR^{2a}, and
a 5-6 membered aromatic heterocyclic system containing from 1-4
heteroatoms selected from N, O and S, wherein from 1-4 hydrogen atoms on
the aromatic heterocyclic system may be independently replaced with a
25 member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆
alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂.

R^{2a} and R^{3a} are independently selected from the group consisting of:

- H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂;

E is a member selected from the group consisting of:



- 10 R⁵ and R⁶ are independently selected from:

- H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, C₀₋₄alkylheteroaryl, C₁₋₄alkylCOOH and C₁₋₄alkylCOOC₁₋₄alkyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl, naphthyl and heteroaryl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂;

G is selected from:



- 20 wherein R⁷, R⁸, R^{7a}, R^{8a}, R^{7b} and R^{8b} are independently a member selected from from the group consisting of:

- hydrogen, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl -C₀₋₄alkylCOOR⁹, -C₀₋₄alkylC(=O)NR⁹R¹⁰, -C₀₋₄alkylC(=O)NR⁹-CH₂-CH₂-O-R¹⁰, -C₀₋₄alkylC(=O)NR⁹(-CH₂-CH₂-O-R¹⁰), -N(R⁹)COR¹⁰, -N(R⁹)C(=O)R¹⁰, -N(R⁹)SO₂R¹⁰, and a naturally occurring or synthetic amino acid side chain, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, -CN and -NO₂;

R⁹ and R¹⁰ are independently selected from:

- 5 H, C₁₋₄alkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, -CN and -NO₂, and wherein R⁹ and R¹⁰ taken together can form a 5-8 membered heterocyclic ring;

J is a member selected from the group consisting of:

- 10 a direct link, -C(=O)-N(R¹¹)-(CH₂)₀₋₂, -N(R¹¹)-(CH₂)₀₋₂-C(=O)-, and -N(R¹¹)-(CH₂)₀₋₂;

R¹¹ is a member selected from the group consisting of:

- hydrogen, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, C₀₋₄alkylheterocyclic ring having from 1 to 4 hetero ring atoms selected from the group consisting of N, O and S, CH₂COOC₁₋₄alkyl, CH₂COOC₁₋₄alkylphenyl and CH₂COOC₁₋₄alkylnaphthyl;
- 15

Z is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1b} substituents;
- (b) naphthyl, which is independently substituted with 0-2 R^{1b} substituents; and
- (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1b} substituents;
- 20

- 25 R^{1b} is selected from:

- Halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, -CN, -NO₂, NR^{2b}R^{3b}, SO₂NR^{2b}R^{3b}, SO₂R^{2b}, CF₃, OR^{2b}, O-CH₂-Ph, O-CH₂-OPh, O-CH₂-CH₂-OR^{2b}, O-CH₂-COOR^{2b}, N(R^{2b})-CH₂-CH₂-OR^{2b}, N(-CH₂-CH₂-OR^{2b})₂, N(R^{2b})-C(=O)R^{3b}, N(R^{2b})-SO₂-R^{3b}, and a 5-6 membered aromatic heterocyclic system containing from 1-4 heteroatoms selected from N, O and S, wherein from 1-4 hydrogen atoms on the aromatic heterocyclic
- 30

system may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and -NO₂;

R^{2b} and R^{3b} are independently selected from the group consisting of:

- 5 H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN and
10 -NO₂;

L is selected from:

H, -CN, C(=O)NR¹²R¹³, (CH₂)_nNR¹²R¹³, C(=NR¹²)NR¹²R¹³, OR¹², NR¹²R¹³, -NR¹²C(=NR¹²)NR¹²R¹³, and NR¹²C(=NR¹²)-R¹³;

R¹² and R¹³ are independently selected from:

- 15 hydrogen, -OR¹⁴, -NR¹⁴R¹⁵, C₁₋₄alkyl, C₀₋₄alkylphenyl, C₀₋₄alkylnaphthyl, COOC₁₋₄alkyl, COO-C₀₋₄alkylphenyl and COO-C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN, and -NO₂;
20

R¹⁴ and R¹⁵ are independently selected from:

- 25 H, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, C₀₋₄alkylphenyl and C₀₋₄alkylnaphthyl, wherein from 1-4 hydrogen atoms on the ring atoms of the phenyl and naphthyl moieties may be independently replaced with a member selected from the group consisting of halo, C₁₋₄alkyl, C₂₋₆alkenyl, C₂₋₆alkynyl, C₃₋₈cycloalkyl, C₀₋₄alkylC₃₋₈cycloalkyl, -CN, and -NO₂;

and all pharmaceutically acceptable isomers, salts, hydrates, solvates and prodrug derivatives thereof.

2. A compound of claim 1 wherein:

A is selected from:

- (a) C₁-C₆-alkyl;
- (b) C₃-C₈-cycloalkyl;
- 5 (c) phenyl, which is independently substituted with 0-2 R¹ substituents;
- (d) naphthyl, which is independently substituted with 0-2 R¹ substituents;
and
- (e) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to
10 ring atoms, wherein 1-4 ring atoms of the ring system are selected
from N, O and S, and wherein the ring system may be substituted
from 0-2 R¹ substituents;

R¹ is selected from:

- halo, C₁₋₄alkyl, -CN, (CH₂)_mNR²R³, SO₂NR²R³, SO₂R², CF₃, OR², and a 5-6
15 membered aromatic heterocyclic system containing from 1-4 heteroatoms
selected from N, O and S;

R² and R³ are independently selected from the group consisting of:

H, C₁₋₄alkyl and C₆₋₄alkylaryl,
m is an integer of 0-2;

Y is a member selected from the group consisting of:

- 20 a direct link, -C(=O)-, -N(R⁴)-, -C(=O)-N(R⁴)-, -N(R⁴)-C(=O)-, -SO₂-, -O-,
-SO₂-N(R⁴)- and -N(R⁴)-SO₂;

R⁴ is selected from:

H, C₁₋₄alkyl and C₆₋₄alkylaryl;

D is absent or is a member selected from the group consisting of:

- 25 (a) aryl, which is independently substituted with 0-2 R^{1a} substituents; and
- (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to
10 ring atoms, wherein 1-4 ring atoms of the ring system are selected

from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

R^{1a} is selected from:

- 5 Halo, C₁₋₄alkyl, -CN, -NO₂, (CH₂)_mNR^{2a}R^{3a}, SO₂NR^{2a}R^{3a}, SO₂R^{2a}, CF₃, OR^{2a}, and a 5-6 membered aromatic heterocyclic ring containing from 1-4 heteroatoms selected from N, O and S;

R^{2a} and R^{3a} are independently selected from the group consisting of:

H, C₁₋₄alkyl and C₀₋₄alkylaryl;

E is a member selected from the group consisting of:

- 10 -N(R⁵)-C(=O)-, -C(=O)-N(R⁵)-, -N(R⁵)-C(=O)-N(R⁶)-, -SO₂-N(R⁵)-, -N(R⁵)-SO₂-N(R⁶)- and -N(R⁵)-SO₂-N(R⁶)-C(=O)-;

R⁵ and R⁶ are independently selected from:

H, C₁₋₄alkyl, C₀₋₄alkylaryl, C₀₋₄alkylheteroaryl, C₁₋₄alkylCOOH and C₁₋₄alkylCOOC₁₋₄alkyl;

- 15 G is selected from:

-CR⁷R⁸- and -CR^{7a}R^{8a}-CR^{7b}R^{8b}-

wherein R⁷, R⁸, R^{7a}, R^{8a}, R^{7b} and R^{8b} are independently a member selected from from the group consisting of:

- 20 hydrogen, C₁₋₄alkyl, C₀₋₄alkyl-C₃₋₈cycloalkyl, C₀₋₄alkylaryl, -C₀₋₄alkylCOOR⁹, -C₀₋₄alkylC(=O)NR⁹R¹⁰, -N(R⁹)COR¹⁰, -N(R⁹)C(=O)R¹⁰, -N(R⁹)SO₂R¹⁰, and common amino acid side chains;

R⁹ and R¹⁰ are independently selected from:

H, C₁₋₄alkyl and C₀₋₄alkylaryl;

J is a member selected from the group consisting of:

- 25 a direct link, -C(=O)-N(R¹¹)-(CH₂)₀₋₂, -N(R¹¹)-(CH₂)₀₋₂-C(=O)-, and -N(R¹¹)-(CH₂)₀₋₂;

R¹¹ is a member selected from the group consisting of:

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hydrogen, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-8} cycloalkyl, C_{0-4} alkylaryl, C_{0-4} alkylheterocyclics, CH_2COOC_{1-4} alkyl, CH_2COOC_{1-4} alkylaryl;

Z is a member selected from the group consisting of:

- (c) aryl, which is independently substituted with 0-2 R^{1b} substituents; and
- 5 (d) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1b} substituents;

R^{1b} is selected from:

- 10 halo, C_{1-4} alkyl, -CN, -NO₂, $NR^{2b}R^{3b}$, $SO_2NR^{2b}R^{3b}$, SO_2R^{2b} , CF₃, OR^{2b} , $O-CH_2-CH_2-OR^{2b}$, $O-CH_2-COOR^{2b}$, $N(R^{2b})-CH_2-CH_2-OR^{2b}$, $N(-CH_2-CH_2-OR^{2b})_2$, $N(R^{2b})-C(=O)R^{3b}$, $N(R^{2b})-SO_2-R^{3b}$, and a 5-6 membered aromatic heterocyclic ring containing from 1-4 heteroatoms selected from N, O and S;

R^{2b} and R^{3b} are independently selected from the group consisting of:

- 15 H, C_{1-4} alkyl and C_{0-4} alkylaryl;

L is selected from:

H, -CN, $C(=O)NR^{12}R^{13}$, $(CH_2)_nNR^{12}R^{13}$, $C(=NR^{12})NR^{12}R^{13}$, OR^{12} , $-NR^{12}C(=NR^{12})NR^{12}R^{13}$ and $NR^{12}C(=NR^{12})-R^{13}$;

R^{12} and R^{13} are independently selected from:

- 20 hydrogen, $-OR^{14}$, $-NR^{14}R^{15}$, C_{1-4} alkyl, C_{0-4} alkylaryl, $COOC_{1-4}$ alkyl, and $COO-C_{0-4}$ alkylaryl; and

R^{14} and R^{15} are independently selected from:

H and C_{1-4} alkyl.

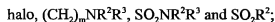
- 25 3. A compound of claim 1, wherein:

A is selected from:

(a) phenyl, which is independently substituted with 0-2 R^1 substituents; and

- (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R¹ substituents;

5 R¹ is selected from:



R² and R³ are independently selected from the group consisting of:

H and C₁₋₄alkyl;

Y is a member selected from the group consisting of:

10 a direct link, -C(=O)-, -SO₂- and -O-;

D is a member selected from the group consisting of:

(a) phenyl, which is independently substituted with 0-2 R^{1a} substituents; and

(b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

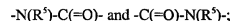
R^{1a} is selected from:

Halo and C₁₋₄alkyl;

R^{2a} and R^{3a} are independently selected from the group consisting of:

20 H, C₁₋₄alkyl, C₀₋₄alkylaryl;

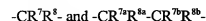
E is a member selected from the group consisting of:



R⁵ and R⁶ are independently selected from:

H, C₁₋₄alkyl, C₀₋₄alkylaryl and C₀₋₄alkylheteroaryl;

25 G is selected from:



wherein R^7 , R^8 , R^{7a} , R^{8a} , R^{7b} and R^{8b} are independently a member selected from from the group consisting of:

- hydrogen, C_{1-4} alkyl, C_{0-4} alkyl- C_{3-6} cycloalkyl, C_{0-4} alkylaryl, $-C_{0-4}$ alkylCOOR⁹,
 $-C_{0-4}$ alkylC(=O)NR⁹R¹⁰, $-C_{0-4}$ alkylC(=O)NR⁹-CH₂-CH₂-O-R¹⁰,
 5 $-C_{0-4}$ alkylC(=O)NR⁹(-CH₂-CH₂-O-R¹⁰)₂, $-N(R^9)COR^{10}$, $-N(R^9)C(=O)R^{10}$,
 $-N(R^9)SO_2R^{10}$, and common amino acid side chains;

R^9 and R^{10} are independently selected from:

H and C_{1-4} alkyl, wherein the NR⁹R¹⁰ group of R^7 , R^8 , R^{7a} , R^{8a} , R^{7b} and R^{8b} is optionally cyclized to form a 5-8 membered heterocyclic group;

- 10 J is a member selected from the group consisting of:

a direct link, $-C(=O)-N(R^{11})-(CH_2)_{0-2}$, $-N(R^{11})-(CH_2)_{0-2}-C(=O)-$, and $-N(R^{11})-(CH_2)_{0-2}$;

R^{11} is a member selected from the group consisting of:

- hydrogen, C_{1-4} alkyl, C_{2-6} alkenyl, C_{0-4} alkylaryl and a C_{0-4} alkylheterocyclic
 15 ring;

Z is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1b} substituents;
 (b) an aromatic heterocyclic ring having from 5 to 10 ring atoms, wherein 1-
 4 ring atoms are selected from N, O and S, and wherein the ring may be
 20 substituted independently by from 0-2 R^{1b} substituents; and
 (c) a fused aromatic bicyclic heterocyclic ring system having from 5 to 10
 ring atoms, wherein 1-4 ring atoms of the ring system are selected from
 N, O and S, wherein the bicyclic ring system may be substituted from 0-2
 R^{1b} substituents;

- 25 R^{1b} is selected from:

halo, C_{1-4} alkyl, OH, OBn, O-CH₂-CH₂-OH, O-CH₂-CH₂-OCH₃,
 O-CH₂-COOH, O-CH₂-C(=O)-O-CH₃, NH₂, NH-CH₂-CH₂-O-CH₃,
 NH-C(=O)-O-CH₃, and NH-SO₂-CH₃;

L is selected from:

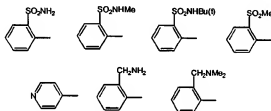
H, $C(=O)NR^{12}R^{13}$, $(CH_2)_nNR^{12}R^{13}$ and $C(=NR^{12})NR^{12}R^{13}$; and

R^{12} and R^{13} are independently selected from:

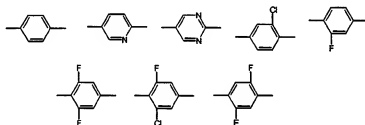
hydrogen and C_{1-4} alkyl.

- 5 4. A compound of claim 1, wherein

A is a member selected from the group consisting of:



- 10 D is a member selected from the group consisting of:



E is a member selected from the group consisting of:

- 15 $-C(=O)-NH-$, $-C(=O)-N(-CH_3)-$, $C(=O)-N(-Bn)-$, $-NH-C(=O)-$, $-N(-CH_3)-C(=O)-$ and $-N(-Bn)C(=O)-$;

G is selected from:

$-CH(-NH_2)-CH_2-$, $-CH(-NH(C(=O)-CH_3))-CH_2-$,
 $-CH(-NH(C(=O)-Ph))-CH_2-$, $-CH(C(=O)-OR^8)-$, $-CH(-R^7)-$,
 $-CH_2-CH(C(=O)-OR^8)-$, and $-CH_2-CH(C(=O)-N(-R^8, -R^8))-$;

- 20 R^7 is a member selected from the group consisting of:

H, phenyl, Bn, and cyclohexyl;

R^8 is a member selected from the group consisting of:

- 138 -

H, C₁₋₆alkyl, and C₃₋₆cycloalkyl;

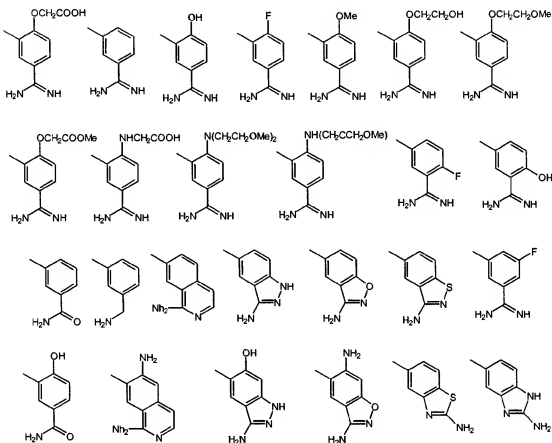
J is a member selected from the group consisting of;

-C(=O)-N(R¹¹)-(CH₂)₀₋₂, -N(R¹¹)-(CH₂)₀₋₂-C(=O)-, and -N(R¹¹)-(CH₂)₀₋₂;R¹¹ is a member selected from the group consisting of:

5

H, methyl, phenyl and benzyl; and

Z and L taken together are a member selected from the group consisting of:



10 5. A compound of claim 1, wherein

A is selected from:

- (a) phenyl, which is independently substituted with 0-2 R¹ substituents;
- (b) naphthyl, which is independently substituted with 0-2 R¹ substituents; and

- (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R¹ substituents;

5 Y is a direct link;

D is selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1a} substituents;
(b) naphthyl, which is independently substituted with 0-2 R^{1a} substituents;
and

- 10 (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

E is -NH-C(=O)-;

- 15 G is -CHR^{7a}-CHR^{7b}-;

J is a member selected from the group consisting of:

-C(=O)-N(R¹¹)-(CH₂)₀₋₂, -N(R¹¹)-(CH₂)₀₋₂-C(=O)-, and -N(R¹¹)-(CH₂)₀₋₂;

Z is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1b} substituents;
20 (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1b} substituents;

R^{1b} is N(R^{2b})-C(=O)R^{3b}; and

- 25 L is H.

6. A compound of claim 1, wherein

A is selected from:

- (a) phenyl, which is independently substituted with 0-2 R^1 substituents;
- (b) naphthyl, which is independently substituted with 0-2 R^1 substituents; and
- (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^1 substituents;

Y is a direct link;

D is selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1a} substituents;
- (b) naphthyl, which is independently substituted with 0-2 R^{1a} substituents; and
- (c) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1a} substituents;

E is $-C(=O)-NH-$;

G is $-CHR^{7a}-CHR^{7b}-$;

J is a member selected from the group consisting of:

- $-C(=O)-N(R^{11})-(CH_2)_{0-2}-N(R^{11})-(CH_2)_{0-2}-C(=O)-$, and $-N(R^{11})-(CH_2)_{0-2}-$;

Z is a member selected from the group consisting of:

- (a) phenyl, which is independently substituted with 0-2 R^{1b} substituents;
- (b) a monocyclic or fused bicyclic heterocyclic ring system having from 5 to 10 ring atoms, wherein 1-4 ring atoms of the ring system are selected from N, O and S, and wherein the ring system may be substituted from 0-2 R^{1b} substituents;

R^{1b} is $N(R^{2b})-C(=O)R^{3b}$; and

L is H.

7. A pharmaceutical composition for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising a pharmaceutically acceptable carrier and a compound of claim 1.
- 5 8. A pharmaceutical composition for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising a pharmaceutically acceptable carrier and a compound of claim 2.
9. A pharmaceutical composition for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising a pharmaceutically acceptable carrier and a compound of claim 5.
- 10 10. A pharmaceutical composition for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising a pharmaceutically acceptable carrier and a compound of claim 6.
- 15 11. A method for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising administering to said mammal a therapeutically effective amount of a compound of claim 1.
12. The method of claim 11, wherein the condition is selected from the group consisting of acute coronary syndrome, myocardial infarction, unstable angina, refractory angina, occlusive coronary thrombus occurring post-thrombolytic therapy or post-coronary angioplasty, a thrombotically mediated cerebrovascular syndrome, embolic stroke, thrombotic stroke, transient ischemic attacks, venous thrombosis, deep venous thrombosis, pulmonary embolus, coagulopathy, disseminated
- 25 intravascular coagulation, thrombotic thrombocytopenic purpura, thromboangiitis

obliterans, thrombotic disease associated with heparin-induced thrombocytopenia, thrombotic complications associated with extracorporeal circulation, thrombotic complications associated with instrumentation such as cardiac or other intravascular catheterization, intra-aortic balloon pump, coronary stent or cardiac valve, and

5 conditions requiring the fitting of prosthetic devices.

13. A method for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising administering to said mammal a therapeutically effective amount of a compound of claim 5.

10 14. The method of claim 13, wherein the condition is selected from the group consisting of acute coronary syndrome, myocardial infarction, unstable angina, refractory angina, occlusive coronary thrombus occurring post-thrombolytic therapy or post-coronary angioplasty, a thrombotically mediated cerebrovascular syndrome, embolic stroke, thrombotic stroke, transient ischemic attacks, venous thrombosis,
15 deep venous thrombosis, pulmonary embolus, coagulopathy, disseminated intravascular coagulation, thrombotic thrombocytopenic purpura, thromboangiitis obliterans, thrombotic disease associated with heparin-induced thrombocytopenia, thrombotic complications associated with extracorporeal circulation, thrombotic complications associated with instrumentation such as cardiac or other intravascular
20 catheterization, intra-aortic balloon pump, coronary stent or cardiac valve, and conditions requiring the fitting of prosthetic devices.

15. A method for preventing or treating a condition in a mammal characterized by undesired thrombosis comprising administering to said mammal a therapeutically
25 effective amount of a compound of claim 6.

16. The method of claim 15, wherein the condition is selected from the group consisting of acute coronary syndrome, myocardial infarction, unstable angina, refractory angina, occlusive coronary thrombus occurring post-thrombolytic therapy or post-coronary angioplasty, a thrombotically mediated cerebrovascular syndrome, embolic stroke, thrombotic stroke, transient ischemic attacks, venous thrombosis, deep venous thrombosis, pulmonary embolus, coagulopathy, disseminated intravascular coagulation, thrombotic thrombocytopenic purpura, thromboangiitis obliterans, thrombotic disease associated with heparin-induced thrombocytopenia, thrombotic complications associated with extracorporeal circulation, thrombotic complications associated with instrumentation such as cardiac or other intravascular catheterization, intra-aortic balloon pump, coronary stent or cardiac valve, and conditions requiring the fitting of prosthetic devices.
17. A method for inhibiting the coagulation biological samples, comprising the step of administering a compound of claim 1 to a biological sample
18. A method for inhibiting the coagulation biological samples, comprising the step of administering a compound of claim 2 to a biological sample.
19. A method for inhibiting the coagulation biological samples, comprising the step of administering a compound of claim 5 to a biological sample.
20. A method for inhibiting the coagulation biological samples, comprising the step of administering a compound of claim 6 to a biological sample.